Portland General Electric
121 SW Salmon Street • Portland, Ore. 97204
PortlandGeneral.com

September 27, 2019

Public Utility Commission of Oregon
Attn: Filing Center
201 High Street, S.E.
P.O. Box 1088
Salem, OR 97308-1088

RE: UM 1856 PGE's Draft Technical Specifications for the Baldock Energy Storage System – Inviting Stakeholder and Commission Review

Pursuant to Oregon Public Utility Commission (OPUC or Commission) Order Nos. 16-504 and 18-290, enclosed is Portland General Electric Company's (PGE's) draft technical specifications for the energy storage system located at the Baldock Mid-feeder. PGE is submitting the technical specifications that are part of the request for proposal (RFP) as this section holds the project specific information and is the substance of a RFP design. By copy of this to the OPUC Docket No. UM 1856 service list, we invite the Commision and stakeholders to review and offer comments to the technical specifications of the project by October 16, 2019.

History of Energy Storage Docket

The Commission opened Docket No. UM 1751, in September 2015, to implement recently passed legislation, House Bill 2193. House Bill 2193 requires PGE and PacifiCorp to submit proposals by January 1, 2018, for qualifying energy storage systems with capacity to store at least five megawatt hours. In Commission Order 16-504, the Commission adopted guidelines and requirements for energy storage project proposals, in late 2016, and a framework for PAC's and PGE's Energy Storage Potential Evaluations.

PGE filed its Energy Storage Proposal and Final Potential Evaluation on November 1, 2017, which were investigated in UM 1856. Pursuant to Commission Order No. 18-290, filed in UM 1856 on October 25, 2018, PGE filed its plan to advance its energy storage modeling cability which was approved by Staff on April 9, 2019, enabling the Baldock project to move forward. In addition, on September 23, Staff found that PGE had provided adequate evidence in its site analysis for the Baldock project; thus PGE is also filing the draft technical specficiations for stakeholder review.

The Commission's competitive bidding requirements for House Bill 2193 projects are as follows:

1. An electric company may award a contract for a project without competition if it determines and presents justification that only a single vendor or contractor is

capable of meeting the requirements of the project.

2. Where the requirements for sole source procurement are unmet, electric companies must use a competitive process to award contracts.
    a. The electric companies will bear the burden of demonstrating that they followed a fair, competitive solicitation process to identify all vendors with the requisite expertise, experience, and capability to install viable projects.
    b. *The electric companies must give the Commission and stakeholders the opportunity to review the electric companies' RFP design and offer nonbinding input* (emphasis added).
    c. The electric companies must summarize and report to the Commission their solicitation process and scoring approach. The report should be included with the formal project proposal submitted to the Commission, or, if bidding occurs after Commission authorization, at a special public meeting to follow.

Enclosed is the draft technical specifications for the Baldock energy storage system.

PGE is seeking stakeholder feedback within the next 15 business days. Feedback should be directed to: puc.filingcenter@state.or.us

Should you have any questions or comments regarding this filing, please contact Kalia Savage at (503) 464-7432. Please direct all formal correspondence and requests to the following email address pge.opuc.filings@pgn.com

Sincerely,

Robert Macfarlane
Manager, Pricing and Tariffs

Enclosures

Draft Technical Specifications for the Baldock Energy Storage System

PORTLAND GENERAL ELECTRIC COMPANY

Baldock Energy Storage System

Technical Specification

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

AC	alternating current
ACI	American Concrete Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
°C	degrees Celsius
CAD	computer-aided design
CFR	Code of Federal Regulations
CT	Current Transformer
DART	Days away, restricted or transferred
DC	direct current
EMI	Electromagnetic Interference
EMR	Experience Modification Rate
E-Stop	Emergency Stop
ESIC	Energy Storage Integration Council
ESS	Energy Storage System
FAT	Factory Acceptance Testing
HMI	Human Machine Interface
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
IEEE	Institute of Electrical Engineers
LV	Low Voltage
MV	Medium Voltage
MWh	megawatt hours
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PCS	Power Conversion System
PDF	Printable Document Format
PF	Power Factor
PQM	Power Quality Meter
psi	pounds per square inch
PT	Potential Transformer
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SEC	Site Energy Controller
SOC	State of Charge or Energy: Nominal Energy Remaining / Nominal Full Pack Energy Available
Specification	Project Technical Specification
TRIR	Total Recordable Incident Rate
UL	Underwriters Laboratory
UPS	Uninterruptible Power Supply
VF	Voltage and Frequency mode
VSI	Voltage Source Inverter/Mode

SCOPE

This Project Technical Specification (Specification), including Appendices, comprise or constitute requirements to design, fabricate, ship, assemble, test, startup, commission, warrant and make ready for service a fully functional energy storage system (ESS) complete with accessories as required by the Agreement. This Specification defines specific engineering, operating and performance requirements for the Project that is intended for installation on the Owner's electric system. The Project is to be designed to be in a restricted access setting and configured to meet applicable standards required of other Owner equipment with respect to safety, operations, maintenance and environmental impact.

1.0 CONFORMANCE TO SPECIFICATION

1.1 Applicable Documents

Except as modified herein, the Project, including the energy storage technology, power conversion system, and site energy controller shall be designed, manufactured, and tested in compliance with the latest versions (including any issued revisions) of the applicable standards of American National Standards Institute (ANSI), Institute of Electrical Engineers (IEEE), National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA), Occupational Safety and Health Administration (OSHA), American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME), National Fire Protection Association (NFPA), and Owner safety practices . See Appendix A for applicable standards and codes.

1.2 Safety

- The Project must be compliant with all applicable provisions of IEEE 1547, Underwriters Laboratory (UL) 1642, UL 1741 Supplement A, UL 1973, and NFPA Codes. The Project must be able to protect itself from internal failures and utility grid disturbances. As such, the Project must be self-protecting for alternating current (AC) or direct current (DC) component system failures. In addition, the Project must be able to protect itself from various types of external faults and other abnormal operating conditions on the grid.
- The Project must be designed in compliance with applicable federal, state, and local safety standards and regulations with regard to construction and potential exposure to chemicals and with regard to container or enclosure resistance to hazards such as ruptures and exposure to fire.
- All Project systems and equipment must be grounded in accordance with the NEC and adhere to the guidelines in IEEE 80 and IEEE 142.
- For all Project equipment, Contractor shall provide information on all known or reasonably foreseeable safety issues related to the equipment, including appropriate responses on how to handle the Project in case of an emergency, such as fires or module ruptures.
- The Project must be designed such as to minimize risk of injury to the workforce and public during installation, maintenance, and operation.
- Visual and audible fire alarms should be included as necessary per all applicable fire and safety codes.

- A physical Emergency Stop (E-Stop) button is required to be installed at all entrances and exits of the buildings or containers. The E-Stop button shall have the ability to open contactors/breakers to the inverter and batteries isolating the DC and AC potential.
- Contractor to submit a copy of Corporate Safety Plans and a comprehensive site-specific safety plan (at least 30 days prior to the start of the Work) that the Contractor and all Subcontractors will understand and follow during execution of the Work. The site-specific safety plan shall incorporate, at a minimum, plans and policies that are at least as stringent as federal, state, and Owner safety regulations and policies. (i.e., include reference to Contractor Safety Program and all Owner Safety Plans/Policies).
- Designated safety personnel during construction of the Project shall have a minimum of five years of safety experience or an equivalent level of skill through a training certification or professional degree.
- Contractor and all Subcontractors must submit historical safety data for review prior to start of the Work: previous three years of safety stats: TRIR, DART, EMR (on official letterhead); and OSHA inspection history and any OSHA citation history. Contractor shall use the following benchmarks for TRIR (less than or equal to 2.0, DART less than or equal to 1.0, EMR less than 1.0) and membership with ISN. Inspections and citations should be evaluated on case-by-case basis. If TRIR, DART, EMR are outside of recommended benchmarks, a risk mitigation plan is required.
- At minimum, Contractor's Site-Specific Safety Plan shall include provisions with respect to:
  - Daily job planning
  - Activity Hazards Analysis
  - Analysis of Utility locations (proper mark-out for underground facilities)
  - Incident reporting procedures
  - Project safety statistics tracking and reporting
  - Personal Protective Equipment
  - Emergency Plans to include evacuations and inclement weather
  - Fire Management (Fire Safety)
  - Excavation plans
  - Sanitation (hand wash/temp. toilets)
  - Demolition activities (if applicable)
  - Procedures for a Regulatory Visit (should one occur)
  - Deficient Project Safety Performance (recovery plan)
  - Site Safety Orientation requirements
  - Security of work zones, material yards, etc.
  - Behavioral Based Safety Plan
  - HAZCOMM
  - OSHA

1.3 Environmental Requirements

- Contractor and its Subcontractors and vendors engaged in the performance of the Work shall comply with all Applicable Laws.
- All Project equipment must be installed in the Owner's local resource area. The project is located in the Willamette Valley near the confluence of the Columbia and Willamette rivers and is subject to extended periods of fog (fresh water), rain, dampness and seismic activity.
- Spill Prevention Control and Counter Measure Plan - Proper site containment when equipment has equal to or greater than 1,320 gallons of liquid.
  - Containment shall include Petro pipe and a lockable drain valve.
  - All containment basins shall include grating as required to access and maintain equipment located in the containment area.
- The Project shall be designed for proper operation without de-rating for the following conditions and limits:
  - During and after an earthquake the system must maintain functionality (operational).
  - Ambient temperature range as defined in Appendix H, Site Specific Information.
  - Zero gas emissions during normal operating conditions.
  - Noise produced by any Project operation shall comply with applicable local noise codes.
  - The Project must be designed to minimize risk of harm to the environment including land contamination or disturbance (footprint), water contamination or diversion, and air emissions, as required by permitting and best Industry Standards.
  - Contractor must provide sufficient information specific to their particular product and the Project to facilitate utility personnel training and communications with emergency response and environmental agencies. Safety Data Sheets shall be provided, as applicable.

1.4 Seismic

- The structural and nonstructural components of all battery containers, enclosures, control shelters/rooms, free standing structures, structural equipment supports, and all associated foundations and anchorages shall be designed and constructed to withstand the effects of earthquake motions and seismic loading in accordance with the requirements of the 2014 Oregon Structural Specialty Code and American Society of Civil Engineers 7-10 with supplements No. 1 and 2 with the following parameters:
  - Risk Category IV
  - Seismic Design Category D
  - Site Soil Class D, unless otherwise determined by the Geotechnical Engineer
  - Ip is 1.5
- All electrical equipment shall be designed to the 'High Seismic Qualification Level' in accordance with IEEE 693 Standard.
- For all anchors embedded into concrete that resist seismic loading, the cracked concrete provisions of American Concrete Institute (ACI) 318-11, Appendix D must be considered.

- Anchor design must be governed by ductile yielding of a steel element (anchor or attachment), unless the exceptions of ACI 318-11, Appendix D are met.
- Post-installed anchors installed into hardened concrete must be an International Building Code Compliant Anchor for Seismic Design Category D and shall be designed and installed in accordance with the cracked concrete provisions

1.5 Specification Interpretation

- Contractor, if in doubt as to the meaning of any part of this Specification, or if Contractor finds discrepancies in or omissions in this Specification, may submit a request for a written interpretation or correction of the Specification. Any request for a written interpretation should be made to the Owner Representative.
- Any interpretation or correction of the Specification will be given in writing by the Owner Representative.

2.0 GENERAL REQUIREMENTS

2.1 Workmanship

All Work must be done and completed in a thorough, workmanlike manner by personnel skilled in their various trades, notwithstanding any omission from drawings or this Specification. All parts of the Work shall be constructed accurately to standard gauge so that renewals and repairs may be made when necessary with the least possible expense.

2.2 Design and Material

All materials used in the Project shall be new and of the specified quality. All components and workmanship must be free from physical and electrical flaws and imperfections. The design shall not only be effective in engineering characteristics, it must comply with the finish requirements stated herein.

2.3 Document Submittals

The Contractor shall provide electronic Printable Document Format (PDF), and one computer-aided design (CAD) file in AutoCAD/dwg format for the Project required by this Specification for the Owner's review. As part of Substantial Completion, final set drawings shall be provided in AutoCAD .dwg format. The review drawings shall be forwarded and be accompanied by a transmittal letter identifying all drawings by drawing number, revision number, and drawing description (title). A list of the drawing numbers, descriptions, revisions, revision dates and types of format shall be provided in a Microsoft Excel format for full tracking of all drawings/documents to be reviewed. This may be used in part as an identification of the listed drawings of the transmittals.

In order to coordinate the progress of the Project design and to verify that the design complies with the Statement of Work, the Contractor shall submit to the Owner design review drawings, calculations and associated documentation at the 30% and 90% completion levels. The review documents shall include, but not be limited to the following design activities: site development, footing and foundation design, conduit, grounding, structural calculations, seismic qualification reports and seismic outline drawings, equipment drawings, design calculations and drawings for the enclosure containing the batteries, and

indoor and outdoor wiring and schematics. These drawings shall be marked "for review" and shall be submitted in the sequence of preparation in order that the design review may be performed in an orderly sequence.

Intermediate partial review data may be submitted at any time in the Project when the Contractor needs clarification of design requirements or to meet the Substantial Completion Guaranteed Date.

The preliminary drawings submitted (30% review) shall be accompanied by design memoranda which shall provide, when applicable, all data, calculations, and information necessary for an engineering review and understanding of the proposed design. The 30% review level is defined as drawings and documents that define the design concept. Examples of documents to be submitted at the 30% level include but are not limited to:

- Site Plan Layout
- AC Single-line Drawing(s)
- DC Single–line Drawing(s)
- Grounding Plan
- Power Conversion System (PCS) Layout and Details
- Energy Storage Layout and Details
- Battery Container/ Control Shelter Outline Drawings
- Foundation Plan
- Heating, Ventilation, and Air Conditioning (HVAC) Drawings and Details
- Fire System Drawings and Details
- Grading and Drainage Plan
- Storm Water Pollution Prevention Plan
- Equipment Specification List
- Access Road Plan, Cross Sections, and Details
- Site Fencing Drawing
- Electrical Load Flow and Short Circuit Calculations
- Purchase Specs or Data Sheets for Long Lead Items
- Battery Container/ Control Shelter

Owner review of drawings will be limited to a review for constructability and compliance with the Specification. The Contractor shall be responsible for the quality control of its drawings and documents and consistency between design documents and compliance to codes. The Contractor shall continue with design work while preliminary drawings are being reviewed.

The Owner shall have the right to require the Contractor to make design alterations for conformance to the design requirements of the Statement of Work without additional costs to the Owner. The review of such alterations shall not be construed to mean that the drawings have been checked in detail, shall not be accepted as justification for an extension of time, and shall not relieve the Contractor from the responsibility for the correctness of the drawings and compliance to the Statement of Work. The

Contractor shall make, at his own expense, any revisions needed to correct the drawings for any errors or omissions which may be found by the Owner. The Contractor shall submit for review multiple packages of final drawings ready for construction (90% review). Calculations and drawings shall be submitted together. After review, the Contractor shall stamp the final drawings "Issued For Construction" to indicate that these drawings will be the official drawings used for construction activities. Drawings submitted at 90% review shall include, but are not limited to:

- Site Plan Layout
- AC Single-line Drawing
- AC Three-Line Drawings
- DC Single–line Drawing
- DC Three-Line
- Uninterruptible Power Supply (UPS) drawings for black start / islanding systems (if applicable)
- Drawings Grounding Plan and Details
- PCS Layout and Details
- Energy storage Layout and Details
- Battery Container/ Control Shelter Drawings and Details:
  - Structural
  - Architectural
  - Plumbing
  - Mechanical
  - Electrical
  - Fire
- Grading and Drainage Plan and Details
- Foundation Drawings, Plans and Details
- Raceway Plan and Details
- Storm Water Pollution Prevention Plan, if required
- Equipment and Materials List / Bill of Materials (BOM) listing major Equipment and Materials
- Control System Diagrams / Logic Diagrams
- Communication System Block Diagrams
- Access Road Plan, Cross Sections, and Details
- Site Fencing Drawing
- Electrical Load Flow and Short Circuit Calculations
- Control Input/Output (I/O) List
- Supervisory Control and Data Acquisition (SCADA) Points List
- Purchase Specs or Data Sheets for All Equipment

- Site Logistics
- Labels and Signage
- Section 2.6 Study Reports
- Communication Network Documents
- Communication Network Block Diagrams
- Equipment Seismic Qualification Reports (including battery racks)
- Structural Calculations
- Commissioning and Testing Documents
- Operations and Maintenance Documents

A final set of signed "Issued for Construction" drawings for each sub-system shall be available on-site before construction of that sub-system may proceed. To the extent required by Applicable Laws, and/or the authority having jurisdiction over Project permits, construction issue drawings shall be signed and stamped by an Oregon registered professional engineer involved in the Project. Electronic registered professional engineer stamps shall be provided for electronic issues.

- The following information shall be shown on each drawing submitted:
  - Contractor's name.
  - Owner contract and release number.
  - Owner equipment number if indicated in the Agreement or Contractor's equipment number if not indicated in the Agreement.
  - Description of drawings (Title).
  - Latest revision and date.
- Construction submittals shall be reviewed by Contractors' registered engineer or architect (as applicable) and, to the extent required by Applicable Laws, and/or the authority having jurisdiction over Project permits, shall bear review stamp from Contractor's registered engineer or architect (as applicable), or the registered engineer/architect's designee, where appropriate. Documentation provided by equipment manufacturers shall not require additional stamp by a registered engineer if those equipment manufacturer documents are included in a 30%, 90% or Issued for Construction (IFC) submittal package. These reviewed submittals shall be submitted to the Owner at a minimum for the following items:
  - As-built drawing markups delivered after completion of Work.
  - Drilled pier construction work plan (if applicable).
  - Backfilling materials.
  - Structural concrete mix design and associated material certifications.
  - Complete reinforcing bar fabrication, details, and bar setting drawings.
  - Anchor bolts.
  - Structural steel shop fabrication drawings.

  - CMU block including certification of compliance with appropriate design ASTM standards (if applicable).
  - Welding procedure specifications, qualifications, and quality control plan.
  - Disposal site for exported soil material.
  - Masonry mortar mix.
  - Grout mix and procedures.
  - Copy of manufacturer's warranty and installers warranty for control shelter.
  - Doors, frames and hardware.
  - Louvers
  - Paints
  - Sealant
  - Cable cut sheets and testing results.
  - Transformer testing results.
  - Inverter testing results.
  - Conductors and grounding rods.
  - Exothermic welds and grounding connections.
  - Conduit, tray, and conduit fittings.
  - Mandrel

- Within 15 Business Days after receipt of the drawings by the Owner for review, reviewed drawings will be returned to the Contractor. If reasonably required in the opinion of the Owner Representative, or if requested by the Contractor, a design review meeting will be held at Owner offices or other mutually agreed upon location with the Contractor's engineer within one week following return of the reviewed drawings to the Contractor. Contractor shall be provided with at least one week notice in advance of such design review meeting. The Contractor's maintained Critical Path Schedule shall provide for the submittal reviews as noted for all submittals. If practicable, any such meeting may be held via conference call for submittals other than the 30%, 90% and Issued for Construction submittal packages.
- Electronic comments in PDF or clearly legible scans of drawing will be returned to the Contractor with a letter designating the review status of each drawing. The review status given to a drawing by the Owner will be one of the following: "No Comments", "Furnish as Corrected" or "Correction Required." Review by the Owner shall in no way abrogate the requirements of the Specification. The Contractor shall be totally responsible for furnishing a complete, coordinated and integrated design which, when finished, is to be workable and consistent with the requirements of the Statement of Work. Review of any corrected documents will be completed by the Owner within 10 business days of receipt.
- If a drawing is designated "No Comments", the Contractor may proceed with the Work covered by the drawing.
- If a drawing is designated "Furnish as Corrected", the Contractor may proceed with the Work covered by the drawing and the corrections shown. However, the Contractor shall promptly revise the drawing in accordance with the requirements of the Statement of Work and submit electronic

copies of the revised drawing to the Owner. If paper copies are requested, they shall follow the delivery of such electronic copies.

- If a drawing is designated "Correction Required", the Contractor shall revise the drawing to comply with the requirements of the Statement of Work and resubmit electronic copies of the revised drawing and related CAD file for review before proceeding with the work covered by the drawing.

2.4 Record Drawings

The Contractor shall maintain a record drawing set on-site at all times with clear markings on the drawings indicating it as the record set. The record set shall be available for Owner review at all times during performance of the Work. The Contractor shall furnish record drawings to reflect any changes including red line drawings made during or after installation and commissioning of the Project. One set of marked-up paper print drawings all with a new revision number shall be forwarded within six weeks from the Substantial Completion Date. A transmittal letter shall accompany the mailing itemizing the revised drawings.

2.5 Project Specific – Operations and Maintenance Manual

No later than six weeks from the Substantial Completion Date, the Contractor shall furnish two complete identical set of detailed Operation and Maintenance Manuals in both print and digital (PDF) formats for the Project. These manuals shall be accompanied by a letter of transmittal and shall have a table of contents, contain all illustrations, assembly drawings, outline drawings, wiring diagrams, replacement parts list that includes part number identification, a list of recommended spare parts, and instructions necessary for storing, installing, operating and maintaining the Project. The illustrated parts shall be numbered for identification. Additionally, these books shall contain instructions and test procedures for integrating the Project into Owner control and monitoring computer networks. All information contained therein shall apply specifically to the Equipment and Materials furnished and shall not include instructions that are not applicable. All illustrations shall be incorporated within the print of the page to form a durable and permanent reference book. Binding holes of all Table of Contents pages, illustrations and drawings bound into the book shall be reinforced with nylon circlets to prevent this information from being torn out of the book.

The Owner will inform the Contractor six weeks after receipt of the Operation and Maintenance Manuals either that there are "No Comments", "Furnish as Corrected" or "Correction Required". If there are "No Comments", the Contractor shall promptly furnish two additional sets identical to the submitted copy. If there are corrections needed, one set will be returned to the Contractor by the Owner. The corrections shall be promptly incorporated in the Operation and Maintenance Manuals and a total of four complete, identical sets of such revised Operation and Maintenance Manuals shall be furnished to the Owner in both print and digital formats.

One additional, identical Operation and Maintenance Manual shall be kept in control shelter.

2.6 Study Reports and Calculations

The Contractor shall submit all design study, calculations, dynamic modeling simulation, shake table testing, and field test reports to the Owner in a timely manner. All reports and calculations shall be signed by an Oregon registered professional engineer and shall list assumptions, study methods, results, significant findings and conclusions.

The Contractor shall prepare the following study reports and calculations as specified below:

- **Seismic and Wind Loading Calculations**: The Contractor shall provide seismic and wind loading calculations for all battery containers, enclosures, control shelter, structures, nonstructural components, equipment and structural supports, and all associated foundations and anchorages as specified in Section 1.4.
- **Seismic Qualification Report**: Contractor shall prepare a report demonstrating the Project's compliance with the seismic standards specified in Section 1.4 for the following:
  - Battery racks IEEE-693-2005-Annex J
  - Batteries – IEEE 693-Annex J
  - Switchgear-IEEE 693-Annex M
  - Step-Up Transformer-IEEE 693-Annex D
  - Inverters (including rack mount)-IEEE 693- Annex L
  - MV/HV Breaker, IEEE 693- Annex C
  - MV/HV Disconnect Switch IEEE 693-Annex E
  - MV/HV Termination and Support Structure, IEEE 693-Annex N
  - Pad-mount Isolation Transformers (Anchorage Only), IEEE 693-Annex D
  - Electronic Devices, Panels, Switchboards, solid-state rectifiers-IEEE 693 Annex L
- **Structural Calculations**: The Contractor shall provide structural calculations for all structural supports and foundations, the battery containers, Control Shelters/Rooms, and equipment foundations and all nonstructural components in accordance with Oregon Structural Specialty Code requirements as specified in Section 1.4 of this document.
- **Grounding System Study**: The Contractor shall perform soil resistivity measurements and studies as necessary to determine the parameters for the Project's grounding system. Grounding studies shall identify step and touch potentials, as applicable, for each facility where new equipment is added as part of the Project scope. The Project grounding system shall be designed to function independently of the adjacent grounding system. The grounding system for the Project may be connected to the ground grid for the adjoining substation at the discretion of the Owner at Contractor's cost. If connected to the adjoining grounding system, the contractor shall perform a study to verify that step and touch potential are within tolerable limits. Connections to and routing of ground cables to connect the ground grid of the adjoining grounding system shall be provided by the Contractor. Grounding for all multi-component outdoor structures shall include two or more independent ground connections. The Project grounding system shall also be designed in such a way as to reduce electromagnetic interference coupled to the grounding system from power electronic converters, such as through single-point grounding systems. Designs and study shall adhere to IEEE 80, IEEE 81, and IEEE 142 where applicable.
- **Electrical Studies**: The Contractor shall provide electrical studies as required to determine control response and settings, including load flow, short circuit, cable ampacity, arc flash analysis, and voltage drop using industry-standard engineering software agreed-upon by the Owner. For the purposes of the system electrical studies, the Contractor shall provide input data for an accurate power flow and dynamic simulation model of the Project compatible with the Owner's CYME database and software. Contractor shall perform dynamic simulations utilizing CYME.

- **Relay and Control Settings:** The Contractor shall provide complete documentation of all protective relay and Project control settings for the Project's batteries, inverters, control systems, and AC systems up to the point of interconnection. Such documentation shall include a protection and control criteria document (separate protection and control criteria documents are acceptable), all calculations, and time current coordination curves used in the development of the settings.

2.7 Testing and Test Reports

- The Contractor shall, within 30 days prior to any on-site testing, submit a "Master Test Plan and Procedures" document indicating the order in which the tests will be conducted, and the test method being used along with required instrumentation for Owner approval.
- The Contractor shall furnish, at the Contractor's own expense, necessary facilities and test equipment for the required tests.
- The Contractor shall notify the Owner not less than two weeks in advance of the day when:
  - Manufacture, fabrication and integration starts for the batteries, inverters, controls and transformers of each major deployment.
  - The batteries, inverters, controls, transformers and other major components allocated for each major deployment are ready for testing and inspection prior to packaging for shipment.
- Should the Owner elect to waive the right of inspection or of witnessing tests and accept certified test reports instead, the Owner will notify Contractor no later than three business days ahead of the scheduled inspection or test.
- Witnessed factory tests shall be made in the presence of Owner personnel. The test procedures shall be subject to review and acceptance by the Owner prior to arrival at testing location, provided that non-acceptance of any part of the procedures is consistent with the Statement of Work. The Contractor shall bear all costs of such testing except for the compensation and expenses of Owner personnel. If scheduling such tests to accommodate the Owner causes schedule delays, then said delays will be accommodated on a day for day basis to the extent they negatively impact the critical path.
- One copy of the certified reports of all tests shall be furnished to the Owner in digital format for review. The Owner will inform the Contractor within two weeks after the receipt of the certified test reports either that there are no exceptions noted or that the test results show noncompliance with the Specification. Contractor shall provide the test data for a representative sample of each of the major components.

2.8 Factory Acceptance Testing (FAT) Requirements

The Contractor shall be responsible for compliance with all standard factory test procedures that check the quality and performance of the Equipment and Materials.

The Contractor shall perform those tests specified below and in other sections of this Specification. The Contractor shall propose additional tests to be conducted if required. Where appropriate, tests should conform to those contained in ANSI, NEMA, ASME, NEC, ASTM, NETA and IEEE standards and guidelines. Where standards are not suitable or applicable, other common industry procedures and mutually acceptable methods shall be used.

If certain tests are performed by firms other than the Contractor, the Contractor shall furnish the test reports and certify that the necessary testing has been performed.

2.8.1 Factory Acceptance Testing of the Battery/Cells

The Contractor shall test and submit test data for the cells designated for use on this Project. At a minimum, the following tests shall be performed:

- Amp hour capacity
- UL 1642 Certificates (if applicable)
- As applicable, maximum noxious and toxic material release rates for same cell design but not necessarily a specific production lot.

The Contractor shall propose a test plan for all required cell tests. Required tests may be proposed as a percentage of the cells in production lots. Test data for production lots other than those being supplied for this Project are not acceptable.

2.8.2 Factory Acceptance Testing of the PCS and Control System

The Contractor shall develop and submit for Owner approval of a FAT Plan. The FAT Plan shall be in general accordance with Appendix C of this Specification. The Contractor shall work cooperatively with the Owner to develop a formal FAT Plan based on the appendix.

At a minimum, sufficient tests shall be conducted to demonstrate that all controls, protective functions and instrumentation perform as designed and are in compliance with this Specification. Successful tests performed on scale models or analog simulators will be deemed to meet the intent of this paragraph. The tests shall demonstrate that the PCS is capable of synchronizing with and operating in parallel with the utility connection. A report along with graphs of each test and a data file will be provided by the Contractor to the Owner upon completion of the FAT. This file should be captured at a minimum of 512 samples per cycle resolution.

Witness test shall demonstrate the following, at a minimum:

- Normal and failure mode operating sequence and protective functions.
- Verification of accuracy of measured input/output voltage and currents.
- Verification of dynamic power factor control via SCADA system (e.g., Communications Protocol).
- Verification of power curtailment via SCADA system (e.g., Communications Protocol).
- Verification of islanding and black start capabilities.

2.9 Site Acceptance Test (SAT)

The SAT shall be in accordance with Appendix F of this Specification. Owner will assist Contractor during the SAT testing. In addition, the Contractor shall demonstrate that all aspects of the System integrate and coordinate as intended. At a minimum, the Contractor shall demonstrate that all control and management systems, including but not limited to, all levels of energy storage management system, PCS

controls, and overall site controls, interact as intended. Other balance-of-plant systems shall be tested in conjunction with the overall system tests (e.g. HVAC, fire alarm, lighting, security).

2.9.1 Actual Operating Experience

It may not be possible due to system constraints to test all facets of the Project function as part of the performance verification tests specified above. The actual operating experience of the Project through Final Completion shall be deemed an extension of the performance verification tests.

Actual operating experience will be documented through Owner-furnished sequence of event recorders, oscillographs, digital fault recorders and other system monitoring equipment capable of identifying system disturbances and associated Project performance. Additional information may be provided by monitoring equipment installed by the Owner at other locations. Operation may also be documented with the Contractor-furnished PQM meters, as determined by the Owner.

2.9.2 Other Compliance Tests

The Contractor is responsible for obtaining both before (or with all equipment de-energized) and after Project installation, measurements to ensure the Project complies with this Specification in the following areas. The Owner reserves the right to perform (or request others to perform), at Owner expense, identical compliance test measurements for the following:

- Broadband frequency signal strength and noise voltage.
- Harmonic voltages and currents adhering to IEEE 519.
- Audible noise measurements adhering to Authority Having Jurisdiction (AHJ) requirements.

2.10 Spare Parts

The Project specific Operations and Maintenance Manual provided by Contractor will list the required spare parts to be furnished with the Project by Contractor. Each spare part shall be interchangeable with and shall be made of the same material and workmanship as the corresponding part included with the product furnished under these Specifications. Enclosed storage space for spare parts required on site shall be provided for by Contractor. If climate-controlled space is required, additional space shall be included in the control shelter or energy storage system enclosure(s).

2.11 Special Tools

The Contractor shall furnish a complete set of any special tools, lifting devices, templates and jigs, which are specifically necessary for installation and/or maintenance of the Project. Any accessories normally furnished with this system required for satisfactory operation of the Project, and not specified herein, shall also be furnished by the Contractor. All tools furnished shall be new and plainly marked for identification. One complete set of tools shall be furnished for the Site.

2.12 Cleaning and Painting

All waterproof enclosures shall be thoroughly cleaned of rust, welding scale, and grease, and shall be treated to affect a bond between the metal and paint which shall prevent the formation of rust under the

paint. A priming coat shall be applied immediately after the bonding treatment. The final finish shall consist of two coats of paint of specified color and type. Contractor shall submit painting specifications and procedures for Owner approval.

Waterproofing is the combination of materials or systems that prevent water intrusion into structural elements of the buildings or its finished spaces.

2.13 Shipping Requirements

- The Contractor shall prepare Equipment and Materials for shipment in such a manner as to protect from damage in transit. Each item, box or bundle shall be plainly and individually identifiable for content according to item number, Owner contract number, Contractor's identifying number, and complete shipping address. The Contractor shall pay particular attention to the proper packaging and bracing of the apparatus to assure its safe arrival.
- Systems, equipment, materials and components shall be transportable from the designates port at normal speeds over North American highways and railways and meet all United States Department of Transportation hazardous materials and other requirements. System components may be shipped separately as needed and assembled on-site. Battery shipments shall adhere to the requirements of Title 49 Code of Federal Regulations (CFR) Part 173.185.
- A complete itemized bill of lading, which clearly identifies and inventories each assembly, subassembly, carton, package, envelop, etc., shall be furnished and enclosed with each item or items at the time of shipment.

2.14 Installation

The Contractor shall be responsible for quality of construction to meet best Industry Standards and design requirements.

2.14.1 Civil/Structural

The battery containers, control shelters and required foundations and structures shall be designed by and under the supervision of a qualified Oregon registered professional engineer. All designs shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

The Contractor shall gain access to the Site from existing public and private roads. Existing roads shall not be blocked or restricted without prior approval of the Owner and local agencies. The Contractor shall be responsible for any damage to public roadways or walkways resulting from the Work.

Existing structures and utilities that are adjacent to or within the limits of the Project area shall be protected against damage. The Contractor shall be fully responsible to 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.

2.14.2 Geotechnical testing

The Contractor shall perform geotechnical investigations and geotechnical report shall be in accordance with the Oregon State Building Code and contain information necessary to complete civil/structural and grounding design. Contractor to determine cable thermal ampacity based on geotechnical investigations.

A copy of any report resulting from any geotechnical investigations performed by Contractor must be provided to the Owner. Geotechnical testing, site monitoring and as-built reporting shall be performed during construction and submitted to Owner on a weekly basis.

2.14.3 Site Development

The Contractor shall perform all necessary studies and calculations for hydrology and drainage, erosion control, landscaping, NPDES (Stormwater Pollution Prevention Plan) and site grading to comply with local agency regulations. The Contractor shall be responsible for any and all surveys (topographic, Dig Alert, potholing, etc.) required to attain an accurate design.

Drainage structures and piping within the Project boundaries should be grounded if constructed of materials capable of conducting electricity.

2.14.4 Excavation

The Contractor shall perform all common and deep excavation necessary for installation of all foundations and utilities. All excavation shall be in accordance with Oregon OSHA regulations and the geotechnical report performed or to be performed by Contractor. Excavation spoils shall be the Contractor's responsibility and may be used for backfill or embankment if suitable for this application as directed by the project geotechnical report/ engineer. Unsuitable or excess excavated material shall be disposed of properly.

The Contractor shall verify that earth material exposed in excavations is consistent with those assumed for the Contractor's foundation designs.

2.14.5 Construction Surveying

The Contractor shall furnish all labor, equipment, material and services to perform all surveying and staking essential for the completion of the Project in conformance with Contractor's design and the Statement of Work. Survey information shall be included in Project as-builts.

The Contractor 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 licensed in the state of Oregon.

2.14.6 Fills

Earth fill material adjacent to and below structures shall conform to the design requirements for the structure and the geotechnical report performed or to be performed by Contractor. Contractor prepared specifications and drawings shall indicate the types of soil to use for particular fills and compaction requirements.

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 which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly.

2.14.7 Fencing

Site perimeter fencing is required for the Project. Such fencing shall comply with the Owner substation fence standard (to be provided upon request).

2.14.8 Lighting

Lighting shall be provided for all indoor and outdoor areas of the project. The lighting system shall provide personnel with illumination for operation under normal conditions and means of egress under emergency conditions. Luminaries shall be LED type, mounted so they are easily accessible for maintenance and lamp change out, to the maximum extent practical; for both interior and exterior. Emergency lighting shall be powered from self-contained batteries, with chargers, within a self-contained emergency lighting unit.

The power supply for the lighting system shall generally be from low voltage lighting panelboards. The emergency egress lighting shall consist of self-contained battery lanterns. Outdoor lighting shall be limited to providing fixtures mounted on building, container, or light standards. Light fixtures shall be Dark Sky compliant to help preserve the night sky from light pollution.

The lighting levels shall be designed in accordance with the Illuminating Engineering Society to provide proper illumination levels recommended. Minimum level in the ESS area shall be 30-foot candles (323 lux) at 30 inches (762 millimeters) above plane, when occupied, and adequate levels for illumination for video and security equipment when unoccupied; 3.0-foot candles (22 lux) at 30 inches (762 millimeters). Minimum level in the control room and maintenance area shall be 50-foot candles (538 lux) at 30 inches (762 millimeters) above floor plane.

Follow state and local lighting energy efficiency standards, as applicable. Electric power to light fixtures shall be switched with motion sensors in ESS rooms. When unoccupied sensors shall reduce levels to minimum for security. Motion sensors with built-in override function shall be provided in areas where the light can be completely turned off; such as store rooms, switchgear rooms, and maintenance area. Wall mounted switches and sensors shall be provided at the latch side of the door entrance.

Electric power to outdoor light fixtures shall be switched with motion or heat detectors to keep lights off when not required. Convenience outlets and switches throughout shall be industrial grade rated for standard voltages and amperes per country standards. Convenience outlets located outdoors shall be provided with weatherproof snap-action covers. Outlets shall be spaced in the energy storage area such that there is a maximum 100 feet (30 meters) distance to a receptacle outlet, unless codes allow or require otherwise. As a minimum, an accessible receptacle outlet shall be reachable within 25 feet (7.6 meters) from each HVAC unit. Provide outdoor receptacles protected by ground fault interrupters, and interior receptacles in locations as required by codes. In finished areas, general-purpose power outlets shall be located on each wall and in no case shall they be located more than 10 linear feet (3.0 meters) apart.

2.14.9 Jersey Barriers

Jersey Barriers are required to protect the Project if installed within 20 feet of public thoroughfares. Jersey barriers may be removed after construction at the instruction of the Owner.

2.14.10 Battery Containers/ Control Shelter

The Contractor shall design, engineer, and provide battery containers/ control shelters suitable for use to house the batteries, control systems and all indoor components common to the Site. The battery containers/ control shelter shall be designed to comply with the Oregon building code requirements. The Contractor shall provide the battery containers/ control shelters commensurate with the Project design life, including but not limited to seismic events, wind loads or other controlling criteria.

The battery containers/control shelters shall be designed with the appropriate insulation to meet local building codes and ensure an energy efficient operation of the HVAC and/or ventilation system. The battery containers/ control shelter shall be designed without shipping splits. The control shelter shall be made from either steel (galvanized), aluminum or stainless steel. The control shelter shall have doors to accommodate installation and replacement of equipment housed in the structure. The control shelter roof shall have a pitch design with a minimum slope of 0.25 inch per linear foot and shall be designed to support interior or exterior loads of 100 pounds per linear foot without compromising the roof load design.

The battery containers/ control shelter shall be equipped with DC cabinet, AC panels and disconnects (480/240/120 V), lights, switches, receptacles, controls rack, fire suppression, HVAC units, push buttons, HVAC controls, cable tray, wireway, grounding system and conduit.

Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

2.14.11 Structural Steel and Connections

All structural steel shall comply to the following applicable materials standards:

- Wide Flange Shapes - ASTM A992
- Angles and Channels - ASTM A36
- Plates - ASTM A572 Grade 50
- High Strength Structural Bolts - ASTM A325N Type 1, or A490
- Washers - Hardened steel, ASTM F436
- Nuts - Heavy hex, ASTM A563
- Welded stud anchors shall be headed arc-welded mild steel studs conforming to ASTM A108, Type B having minimum yield strength of 51,000 pounds per square inch (psi) and a minimum tensile strength of 65,000 psi.
- Anchor Bolts - ASTM F1554 Hex Head, Grade 36 or Grade 55
- Electrodes for Welding - Electrodes shall be E70XX 70ksi tensile strength, minimum.
- All structural steel shall be hot-dipped galvanized in accordance with ASTM 123 and all mill certifications shall be available. Structures shall be fabricated such that double dipping is not required.
- Bolted connections shall be ASTM A325 with hardened washer and heavy hex nuts installed as snug-tightened in accordance with the Research Council on Structural Connections Specification for Structural Joints Using ASTM A325 or A490 Bolts.

- All welding shall comply with the requirements of AWS D1.1, Structural Welding Code - Steel. Welders and welding processes shall be qualified in accordance with AWS D1.1.

2.14.12 Foundations and Concrete Work

The Contractor shall furnish all labor, equipment, materials and services to layout, design and construct all foundation and concrete work required for the Project. The Contractor shall provide foundations for all equipment and structures, as appropriate, including but not limited to shelters, containers, buildings, transformers, switches, breakers and instrument transformers.

ACI 318 and Oregon Structural Specialty Code shall be used for the design of foundations. All concrete exposed to weather or in contact with soil shall be designed to be compatible with the life of the Project.

The appropriate manufacturer shall specify the quantity, size, and location of anchor bolts for enclosures and equipment per seismic qualification reports. Embedded steel items shall be hot dip galvanized. Anchor bolts and embedded steel items subject to corrosive action shall be fabricated from stainless steel.

Concrete shall be batched, mixed and delivered in accordance with the requirements of ACI 301. Reinforcing shall be detailed and fabricated in accordance with ACI 315. Details of concrete reinforcement not covered in ACI 315 shall be in accordance with the CRSI manual. Concrete placing methods shall conform to the requirements of ACI 301, 304, and 318.

The Contractor shall provide the services of an independent testing agency to perform tests on concrete material such as compressive strength, slump, concrete mix designs, during the course of the Work. Testing, evaluation and acceptance of concrete shall be done in accordance with the requirements of Chapters 16 and 17 of ACI 301. Any concrete that does not meet the requirements shall be replaced with no increase to the Purchase Price.

2.14.13 Mechanical

All exposed surfaces (inside or outside) of ferrous parts shall be thoroughly cleaned, primed, and painted or otherwise suitably protected to survive outdoor conditions for the design life of the Project.

The containers housing the energy storage system and any other outdoor enclosures or shelters shall be waterproof and capable of surviving, intact, under the Site environmental conditions for the design life of the Project. Flat Roofs are not allowed – minimum roof slope shall be 0.25 inch per linear foot.

Components mounted inside of the building and any other enclosure shall be clearly identified with suitable permanent designations that also shall serve to identify the items on drawings provided.

- The Project shall include an HVAC or ventilation system for the building(s) housing the energy storage system(s) and control shelter which shall be seismically anchored. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.
- The Project shall be designed to maintain component temperatures within design limits for all modes of planned Project operation. The HVAC system shall be sized to maintain ambient temperatures in the building to 25 degrees Celsius (°C) +/- 5°C during all operating modes and ambient conditions.

- HVAC communications and control technology shall make use of the best Industry Standard components and be compatible with the Owner's existing environment for substation communications infrastructure.

2.15 Quality Assurance / Quality Control

2.15.1 Quality Control Program

- The Contractor shall establish, implement, and maintain a comprehensive Quality Control (QC) Program, which shall be reviewed for approval by the Owner prior to implementation. This program shall include provision of a qualified, on-site Quality Assurance / Quality Control (QA/QC) support staff for the duration of the Project.
- The QC Program shall clearly establish a QA/QC Manager and/or staff with the responsibility and authority to inspect the Work, to enforce the quality requirements of the Statement of Work and the Agreement, and to verify the effectiveness of problem resolutions and corrective actions.
- The QC Program shall be capable of assuring that the design, construction, purchasing, manufacturing, shipping, storage, testing, inspection and examination of all equipment, materials, procedures, and services shall comply with the requirements of the Agreement and building code requirements. Reports generated under the QC program must be submitted to the Owner within three days of receipt.
- The Contractor shall provide all equipment, materials, and labor required to perform all Work in support of QA/QC. As a minimum, this applies to soil density, concrete, welding, and any laboratory tests. Any Subcontractors or third-party inspectors hired by Contractor to perform any Work in support of QA/QC shall be subject to the approval of the Owner.
- The Owner shall have the right to independently review and inspect all Work associated with the Project that occurs or will occur at the Site. This may include review and inspection by third parties and contractors of the Owner.

2.15.2 Quality Assurance Manual

The QC Program shall consist of one or more bound sets of documents comprising a single Quality Assurance Manual. The form and format of the Quality Assurance Manual is at the discretion of Contractor and its Subcontractors. Upon review and final approval by the Owner, it shall become the sole guide for Contractor and all its Subcontractors for quality performance of all Work on the Project. The content of the Quality Assurance Manual shall include written descriptions of QA/QC policies, procedures, methods, instructions, exhibits, or other quality assurance descriptions. An uncontrolled copy of Contractor's corporate QC manual shall be provided to the Owner Representative. The Owner shall at all times have access to all QA/QC documentation, and shall be provided copies upon request.

The Contractor's Quality Assurance Manual shall include, at a minimum, control procedures or methods to assure the following:

- The establishment of on-site QA/QC staff.
- A plan for receipt inspection, in-progress inspection, examination, and testing of the equipment and material installed by Contractor.

- A description of the authority and responsibilities of the persons in charge of the quality assurance program.
- Current and accurate maintenance of design documents, drawings, specifications, quality assurance procedures, records, inspection procedures, and purchase control documents.
- Conformance of purchased materials, equipment and services to the requirements of the Agreement.
- Proper performance of receipt and in-process inspections as well as equipment examinations, testing, corrections as well as checkout procedures.
- The inclusion of adequate inspection and quality of all Contractor's subcontracted work and shop fabricated components.
- Shop inspections are performed and documented at an adequate frequency rate.
- Assurance that the quality of all special processes such as welding, and any other nondestructive testing is properly inspected, verified, and documented.
- Assurance that the proper methods are employed for qualifying all personnel performing welding and non-destructive testing.
- Assurance that inspection hold points are identified and monitored in coordination with the Owner Representative.
- All deviations and non-conformance will be communicated to the Owner in writing within three days.

2.16 Required Training Courses

The training courses described below, with accompanying written text, shall be a live presentation at an Owner facility with the Owner having the right to video tape the training course. Such taped training will be used only for training of new personnel and will be subject to confidentiality agreements, and other protections of Contractor's Intellectual Property. The training course shall cover all aspects of installing the Project, a pictorial breakdown of the energy storage subassemblies, procedures related to emergency response (ruptured modules, fire, etc.), and operation and control of the Project.

2.16.1 General

The Contractor shall provide training for the Project as specified below. The Contractor shall determine the content and duration for each training session. The suggested class durations in this 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 except the orientation training.

2.16.2 Orientation Training

The Contractor shall provide two orientation training sessions. It is anticipated that each session will last half a day. These sessions shall be suitable for managers, supervisors, professional and technical personnel. Each session will be limited to a maximum of 20 people.

The orientation training sessions shall be scheduled before commencing Acceptance Testing. An outline for this orientation training shall be submitted to the Owner 90 days ahead of the actual date of training.

Approval of this outline shall be obtained from the Owner. The Owner will provide comments and/or approval at least 30 days before the scheduled training date.

2.16.3 Operator Training

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

2.16.4 Maintenance and Diagnostic Training

The Contractor is responsible for providing necessary training on energy storage and inverter diagnostic software which includes a set of the necessary cables to diagnose these issues. This training shall be completed onsite using the Owner's field personnel equipment. Documentation of the software and steps needed to communicate with various equipment will be supplied by the vendor.

3.0 FUNCTIONAL REQUIREMENTS

3.1 General

The Project will serve multiple purposes, each represented by a control mode. These modes will all be supported within the system capabilities and self-protection requirements. The Project shall be able to move freely between each mode of operation at any time and operate under multiple modes simultaneously, within the system capabilities.

The Contractor shall specify the method used to determine the point where further discharge is no longer practical or safe and the storage media must be recharged before further use. All modes will be limited by the Contractor specified discharge limit to avoid damage to the Project. Termination of any operating scenario by the discharge limit, without reaching rated capacity discharge, will be included in the availability calculation unless the discharge was initiated with the energy storage partially discharged.

The Project shall be capable of functioning in the modes currently available within the Contractor's software.

For all modes, except modes that respond to abnormal system conditions, the Project shall ramp to the required output at an Owner selectable rate. Following a rated discharge or termination of the mode command, the Project shall ramp to zero at an Owner selectable rate suitable to allow other generation to follow. The total energy delivered shall be inclusive of the energy required to ramp the system to zero. Termination of operating modes due to reaching the discharge limit shall take into account the ramp down energy required.

3.2 Control Modes

The following sections describe the control/operational modes and sources of commands for the Project. Contractor shall work with the Owner to ensure that the appropriate command and source hierarchy are

enforced by the Project. Clarification on specific Site Energy Controller behavior relating to these modes is provided in Section 4.12 and Appendix E.

3.2.1 Offline

The Project should open the storage media breaker/contactor(s), inverter AC output breaker/contactor(s), and de-energize non-critical power supplies. It should physically isolate the inverter output from the grid, not just provide a zero output, to prevent interaction with the grid (nominal auxiliary load contactors may continue to serve these loads). This mode includes both normal shutdown and system trips requiring reset.

The control system shall initiate the offline mode under the following conditions and remain in the offline state until a reset signal, either local or remote, is initiated.

- Emergency trip operation.
- AC circuit breaker trips that isolates the Project from the grid.
- Smoke/fire alarm and suppression operation.
- Control logic trouble.

3.2.2 Standby

The Project controller should close the inverter AC output contactor after synching, but neither charge nor discharge, and only draw necessary auxiliary load.

When the Project controller is in Frequency Response or Contingency Reserve modes, it may spend long amounts of time in standby mode. The Project is expected to maintain a state of charge of 100% (or other SOC setpoint as provided from the Owner's controller) and be prepared to respond to a signal for discharge within the specified time. The Project controller will maintain a requested SOC within +/-1%.

3.2.3 Contingency Reserve (Spinning and Non-Spinning)

The Project must respond from an idle state to a request for contingency reserve within two seconds of receiving the command. From that time, the battery output must ramp up at a rate of at least 250 kW per second until the full rated MW output of the system is achieved. The full rated MW output shall be maintained until a ramp-down and stop command is issued. If the Project would be depleted of charge prior to receiving the ramp-down and stop command, the system will go into standby mode. It will not recharge until the request for non-spinning reserve is de-asserted.

When ramp-down and stop is received, within two seconds the Project will ramp down at a rate of 100 kW per second until the MW output is less than or equal to 500 kW. Once the output is less than or equal to 500 kW, the Project will be capable of recharging at 500 kW until a user-defined SOC setpoint is achieved. The control for this service will reside in the PGE plant controller. The Contractor's controls must respond to a setpoint for MW and requested ramp rate.

Contingency reserve will be dispatched up to eight times per year.

3.2.4 Frequency Response

The Project shall charge or discharge in response to an analog signal, received from the Owner's plant controller, while maintaining a defined target SOC over time.

The Project must respond from a standby state to a request for frequency response within two seconds of receiving the command. From that time, the Project output must ramp at a rate of 500 kW per second until the full rated MW output of the system is achieved. The full rated MW output shall be maintained for three minutes following which the output will ramp down at a rate of 25 kW per second. When MW output reaches zero, the Project will recharge at 500 kW until the target SOC setpoint is achieved.

Frequency response will be dispatched up to 50 times per year, potentially multiple times within the same 8-hour period.

3.2.5 Active Power Regulation

The Project shall charge or discharge in response to an analog signal to mitigate load swings on the connected utility grid. Whenever load is quickly increased or decreased, the system should work in the opposite direction to counteract the rate of change and smooth the net output.

The Project must be capable of performing regulation according to Area Control Error (ACE) signals. The control for this service will originate from the Owner's plant controller. The Project must be able to respond to these MW signals within four seconds or less. Response is defined as the time from the Project controller receiving a MW setpoint until that steady-state MW output is achieved.

The Project shall be capable of both positive (supplying) and negative (absorbing) MW setpoints, which may be of any magnitude up to 100% of the system's real power rating. Over time, these MW setpoints are intended to be energy neutral (no net gain or loss in energy). Under active power regulation, the allowable SOC range shall be kept between a minimum of 50% and a maximum determined by the Project's rated SOC limit. In the event battery SOC is at a level where the requested setpoint (either positive or negative MWs) cannot be met, the Project controller shall respond only to MW setpoints for the polarity it can achieve. The Project will resume responding to MW setpoints of both polarities once the battery SOC has returned to an acceptable range.

The Project shall be operated in regulation mode twenty-four times per year (190 hours total per year).

Contractors must stipulate clearly how the thermal limitations of their system would impact this service.

3.2.6 Reactive Power Regulation

The Project will respond to kVAR setpoint requests from the Owner's plant controller within four seconds. Setpoints may be constant or variable kVAR outputs in order to maintain voltage using closed-loop proportional integral control. The Project must be able to regulate kVAR to within +/- 1% from 100 kVAR up to its full nameplate rating. The kVAR controller will reside within the Project's control system. Setpoints for kVAR output will originate from the Owner's plant controller. Depending on the service(s) being requested at any given time, the Project may be asked to provide reactive power regulation while simultaneously being in standby for another service such as frequency response or spinning reserve. Reactive power regulation should be operable simultaneously with other services, provided that the MVA rating of the system is not exceeded.

The only limitation for providing this service must be the overall MVA rating of the Project.

3.2.7 Voltage Regulation

The Project shall provide capacitive or inductive VARs at varying levels according to an analog or digital control signal to maintain a defined voltage level. Voltage deviation should be controlled within +/- 1% of the desired setpoint value.

The Project shall also provide for closed loop proportional integral voltage control. Under this service, the Owner's plant controller will act as the closed loop controller. The Project's controller will receive kVAR setpoints from the Owner's plant controller.

3.2.8 Load Smoothing

The Project shall charge or discharge in response to analog signals to mitigate load swings on the connected utility grid. Whenever load is quickly increased or decreased, the Project should work to counteract the MW rate of change and smooth net output. The system shall be capable of transitioning from full rated charge current to full rated discharge current in 50 milliseconds or less.

Load smoothing is an ancillary service whereby the ESS will follow MW setpoints originating from the Owner's plant controller. These setpoints will generally follow the system load but the Project should be capable of transitioning from full rated charge to full rated discharge as needed. Setpoints can be negative or positive from zero to the full system MW rating. Ramp rates both up and down will be 250 kW per second. Each time this service operates, it is expected that the depth of discharge will be 100%.

This service should be expected to operate 120 times per year.

3.2.9 Automatic Generation Control

The Project shall be capable of Automatic Generation Control (AGC) similar to that of rotating machinery. The Project output will be controlled by a remote signal from the Owner's plant controller. The Project voltage and frequency controls shall regulate the output based on appropriate Owner selectable droop settings. The operation in the AGC mode shall be limited by the Contractor specified discharge limit for the storage media. Following operation in the AGC mode, the Project shall ramp-down linearly to zero output at an Owner selectable rate.

The Project shall also be tasked with charging and discharging according to requests from the Owner's Energy Management System. These commands (setpoints) will come to the Project's controller from the Owner's plant controller. The charge or discharge setpoints should be assumed to be constant at up to the full Project MW rating, with expected depths of charge/discharge to 100%. Charging ramp rates are anticipated to be 250 kW per second, while discharge ramp rates should be Owner configurable.

This service should be expected to operate 240 times per year.

3.2.10 Renewables Following

The Project must be capable of using fast, relatively low magnitude real power outputs to mitigate the intermittency of renewable generation and normal load. The Project will receive real power setpoints, both positive and negative, from the Owner's plant controller on a sub-second frequency. The Project

must respond to these setpoints in no more than 0.7 seconds. These setpoints are never greater than 500 kW.

3.2.11 Blackstart and Intentional Islanding

The Project shall be able to operate without the utility reference voltage and frequency in response to an external analog or digital signal to supply power to the connected loads once disconnected from the grid. Additionally, the Project shall be able to synchronize and reconnect back to the utility.

The Project must be capable of performing blackstart and creating an intentional island of the distribution feeder. Contractor is responsible for providing control power as necessary to the Project via separate UPS. This requirement excludes environmental systems (HVAC). The Project must be capable of regulating voltage and frequency, closing into a dead 12.47 kV bus, and serving load up to its full nameplate rating. The Project should be capable of transitioning from an offline state to serving load within one minute under intentional islanding conditions. Voltage regulation must be within +/- 1% of nominal and frequency regulation must be 60 Hz +/- 0.1%. In this state, the Project must be capable of serving load for one hour. If during this time electrical service to the HVAC is required, the Project must be capable of providing its own HVAC service.

Intentional islanding will be requested for certain types of utility outages that do not involve a downstream fault. Customer owned devices will determine if conditions allow for an intentional island. Prior to intentional islanding, the feeder will go to a fully de-energized state. Owner's equipment will determine whether or not to intentionally island within one minute. This includes any distribution switching that may be required. Once the determination is made to island and distribution switches are properly configured, an intentional islanding request will be sent from Owner's plant controller to the Project's control system. Contractors will clearly stipulate in their proposals the additional cost for providing blackstart service (including the cost of maintaining control power and HVAC services during an outage).

This service shall be required up to two times per year.

3.2.12 Cold Load Pickup

The Project must be able to reduce cold load pick-up after a utility outage through use of a return to grid timer. The return to grid timer will reside in the Project's controller and be adjustable based on setpoints from the Owner's plant controller. To mitigate cold load pick-up, the Project will return to grid with no delay once utility power is restored and ramp up to a real power setpoint established by the Owner's plant controller.

Contractor shall assume that the real power setpoint will be the Project's full nameplate rating. This output is to be maintained for one hour after which the Project output will ramp down at a rate of 250 kW per second and return to normal operation.

3.2.13 Target SOC

The Project should charge according to its own optimum method considering available power limits to reach a defined SOC value. If the system SOC falls below the stated SOC dead band, the system shall charge to reach the desired set point.

The Contractor shall design the charging system to ramp up from zero to the maximum demand at an Owner selectable ramp rate to avoid shocking the system and allow generation to easily follow load. The Contractor shall provide a curve showing how demand from the Owner system varies with time throughout the charging cycle. The Project control system shall allow the Owner dispatcher to remotely initiate this mode. The maximum demand required by the charging cycle shall be Owner selectable, but shall not exceed the Contractor specified charge rate. The Contractor shall provide data showing how the recharge period varies as maximum demand decreases.

The Contractor shall also specify restrictions, if any, on operation of the Project during any portion of the charge cycle. The Contractor shall provide a curve or table and data showing the state of charge as a function of time.

3.2.14 Manual/HMI

The Project shall be capable of being operated manually from an operator HMI. All energy storage system functionality shall be available via this HMI including all control modes, operating parameters or setpoints and monitored information/status.

This operator HMI shall be capable of locking out other control modes and signals being received from the Owner's other integrated systems such as Area Control Error (ACE), Energy Management System (EMS) and Automatic Generator Control (AGC) sources.

3.2.15 Integration to Other Owner Control Systems

The Project shall be capable of being integrated with other Owner control systems.

3.3 Permissive Operation States (applies only to Islandable Systems)

A system of operational states shall permit the use of each mode of operation of the Project. Permissions will be granted by the Owner via an Owner-specified process. The operational states are Island and Blackstart. The descriptions are in the following sections.

3.3.1 Island

Island permission shall authorize the Project to operate in Voltage and Frequency (VF) mode, in island with the utility grid. All necessary switching of islandable and non-islandable load and disconnection from the grid shall be done by the Owner's distribution personnel. Only after grid voltage is restored for the specified delay time, and all necessary switching back to normal has been completed, shall the system be allowed to reconnect with the operator's permission.

3.3.2 Blackstart

Blackstart permission shall authorize the Project to blackstart from a de-energized state, operate in VF mode and island from the utility grid. All necessary switching of islandable and non-islandable load shall be done by the Owner's distribution personnel. Only after grid voltage is restored for the specified delay time, and all necessary switching back to normal has been completed, shall the system be allowed to reconnect with the operator's permission.

4.0 TECHNICAL REQUIREMENTS

4.1 General

The Project shall include the energy storage system, power conversion systems (inverter), pad-mount transformers, cabling, shelters, all associated control and communication interface systems, all switchgear and other interconnection equipment and any auxiliary loads necessary to support its operation to the point of interconnection with the utility.

All loads necessary to operate and protect the Project, such as controls, cooling systems, fans, pumps, and heaters, are considered auxiliary loads internal to the system.

The "Point of Interconnection" shall be defined per the Scope of Work and indicated in Appendix B of the RFP.

4.2 Storage Capacity

The Project shall be rated in terms of net delivered power and energy to the Point of Interconnection. All system loads and losses, including wiring losses, losses through the contactor/static switch, power conversion losses, auxiliary loads, and chemical/ionic losses are considered internal to the Project and ratings are net of these loads and losses as measured (or calculated if not measured) to the Point of Interconnection.

In such cases where auxiliary loads (such as cooling systems) are periodic in nature, ratings may be described for conditions in which these loads are active in the worst-case conditions (or alternatively provide sufficient supplementary information such that ratings under these worst-case conditions may be easily determined).

The Contractor shall scale the reported State of Charge of the energy storage system so that 0-100% represents the maximum range of energy storage capacity available to the Owner regardless of the actual state of charge of the system. A reported 0% state of charge shall indicate that no further discharge of the system is permitted, and a reported 100% state of charge shall indicate that no further charging of the system is permitted. This range shall permit the Owner to fully realize the rated energy storage capacity of the system (e.g., for a 1.0 megawatt hour [MWh] system, the Owner shall be able to discharge 1.0 MWh of energy when discharging from a reported 100% to a reported 0% state of charge).

4.3 Ratings

Following are fundamental Project unit ratings. Note that power, energy, and ampacity ratings apply through the full operating temperature range, as defined for the Site unless otherwise noted.

4.3.1 AC Voltage

Nominal interconnection voltage is 12.47 kV [±5%]

Plant-side distribution voltages shall be 12.47 kV for interconnection with the local utility substation.

4.3.2 Round-trip Efficiency

The roundtrip AC-AC energy efficiency, measured at the Point of Interconnection, shall be provided and include parasitic and auxiliary losses under worst case conditions prescribed in the FAT Plan.

The calculation is as follows:

$$\eta = \frac{kWh_{out}}{kWh_{in}} \times 100\% = \frac{(rated\ discharge\ power) \times (discharge\ time)}{(rated\ charge\ power) \times (charge\ time) + losses} \times 100\%$$

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

4.3.3 Parasitic Losses

The total Energy Storage System unit losses shall be determined for standby operation, including power electronics and any environmental controls such as HVACs.

4.3.4 Self-Discharge

Contractor shall provide self-discharge characteristics.

4.3.5 Basic Insulation Level

The Energy Storage System AC system equipment shall have a Basic Insulation Level in accordance with IEEE standard for each piece of equipment.

4.3.6 Inrush Capability

It may be advantageous to the Owner for the Project to have short time overload capabilities. This may occur for power system disturbances in which both real and reactive power is required for a short period of time to control both frequency and voltage excursions.

The Contractor shall provide a curve showing the inherent overload capability (if any) of the Project as a function of time. It is not a requirement of the Specification to design specific overload capability into the Project.

When islanded, the Energy Storage System shall also have capability for 1.5 x rated MW and 1.5 x rated MVA for one minute. This inrush duty will be four times per hour on top of continuous, full load.

4.3.7 Auxiliary Voltage

Auxiliary voltage will be site specific and captured within Appendix H of the RFP.

4.3.8 Power and Energy

System ratings are defined in kVA (AC) or MVA (AC) and kWh (AC) or MWh (AC) as measured at the Point of Interconnection.

4.3.9 Design Ambient Temperature Range

Reference Appendix H for site specific information.

4.3.10 Audible Noise

The maximum sound level generated from the Project and any associated equipment supplied by the Contractor under any output level within the Project operating range, shall be limited to levels specified by Applicable Laws. The Contractor shall comply with all Applicable Laws that may apply to the Project installation as determined by the jurisdiction applicable to the site.

The audible noise level in the Project control room if separate from areas housing inverters, cooling equipment, etc. shall meet OSHA requirements for normally occupied areas.

The Contractor shall make audible noise measurements before and after commissioning of the Project for the purpose of verifying adherence and compliance with the local ministerial ordinance and requirements. The measurements shall be made at various locations using a Type 1 sound level meter that complies with the requirements of ANSI S1.4-1983 "American National Standard Specification for Sound Level Meters."

4.3.11 Broadband Interference

The Contractor shall take necessary precautionary measures to ensure that there will be no misoperation, damage or danger to the Project due to broadband interference and effects. The Contractor shall ensure that there are no discharge sources from the Project and related equipment that could cause interference with radio and television reception, wireless communication systems, or microwave communication systems per the 47 CFR Part 15. The Contractor shall propose any necessary mitigation to ensure that communication is not adversely affected.

The Contractor shall make measurements before (or with all equipment de-energized) and after commissioning of the Project for the purpose of verifying compliance with the broadband interference requirements.

All broadcast signals, radio noise, television interference and broadband interference measurements shall be made with instruments that comply with the latest revision of ANSI C63.2, "American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specification." IEEE Standard 430, "IEEE Standard Procedures for the Measurement of Radio Noise from Overhead Power Lines and Substations" defines the measurement procedures that shall be used.

4.3.12 Interference and Harmonic Suppression

The PCS shall not produce Electromagnetic Interference (EMI) that will cause misoperation of instrumentation, communication, or similar electronic equipment within the Project or on the Owner

system. The PCS shall be designed in accordance with the applicable IEEE standards to suppress EMI effects.

The Project must meet the harmonic specifications of IEEE 1547 and IEEE 519 and comply with requirements outlined in the Energy Storage Integration Council (ESIC) technical specifications spreadsheet located in Appendix G. Harmonic suppression may be included with the PCS or at the Project AC system level. However, the Contractor shall design the Project electrical system to preclude unacceptable harmonic levels in the Project auxiliary power system.

4.4 External AC Power Interface(s)

4.4.1 Termination

All terminations and locations of terminations shall be pre-approved by the Owner and specified in the appropriate submitted drawings. The Project shall comply with any applicable owner interconnection standard.

4.4.2 Isolation/Disconnect

The Project shall be equipped with a means to isolate the power conditioning system from the substation. This may be accomplished through a lockable breaker.

A 12.47 kV interconnection isolation disconnect switch shall be placed directly on the line side of each metering section. The disconnect switch shall be lockable and have a visible break. The device does not have to be rated for load break nor provide over-current protection. The Owner shall have full access and control over this device.

A LV source side isolation contactor shall be provided. The disconnect breaker shall be lockable and have a visible break. It shall be capable of breaking the full rated power of the system. The contactor will be operated by the ESS control and will also have provisions to be operated manually. The utility will have full access and control over this device.

4.4.3 Use for Auxiliary power

The auxiliary power system shall include, but is not limited to, all step-down transformers, breakers, fuses, motor starters, relaying, panels, enclosures, junction boxes, conduits, raceways, wiring and similar equipment, as required for the Project operation.

4.4.4 Power Quality Metering and Telemetry

Contractor shall provide its own Current Transformers (CT) for protection and internal metering, and controls for Project operation. Contractor to provide local utility compliant metering and telemetry. Contractor to provide Potential Transformer (PT) connection points for synching and telemetry. Contractor to provide one revenue grade power quality meter installed on the line side of the main breaker to validate system performance.

4.4.5 System Protection Requirements

Contractor shall adhere to rules and regulations described on the Owner's Electric Distribution System Interconnection or Generation Interconnection Handbook if available. For the avoidance of doubt, the requirements of the applicable Interconnect Handbook shall apply to all aspects of the project and not just the system protection. If Owner Handbook is unavailable the contractor shall adhere to IEEE and Manufacturer device setting recommendation for protective system settings.

Protection and coordination for the "plant-side" system including batteries, DC combiner panels, inverters, AC combiner panels, transformers, auxiliary systems, and switchgear (where applicable) shall adhere to IEEE 242.

Protection relays for the interconnection shall be utility grade and shall meet the minimum requirements specified in IEEE C37.90 (latest edition) including requirements for EMI and surge withstand according to applicable standards for the intended location of the Project. A complete protective relaying system based on Industry Standards shall be a part of the AC system. The protective relaying and metering shall be integrated with the Project control system and a communications channel provided to the Owner's SCADA system. However, integration into the Project control system shall not circumvent normal protective relaying functions.

All protective equipment and schemes shall be properly coordinated with the Owner protection engineering department. The Contractor shall use Schweitzer Engineering Laboratories (SEL) microprocessor-based protection equipment to the extent practical. The interconnection relay shall be a SEL relay with Mirrored Bits capability. The low side bus and cable shall be protected by multifunction feeder protection relays. Testing of protection equipment shall be conducted by InterNational Electrical Testing Association (NETA) certified technicians. The NETA certification number of the tester shall be documented on all test reports.

4.5 Coordination of Controls

The Contractor shall provide a communications channel with Owner relaying at the interconnection distribution switch. This communications channel will provide permissions to island and black start. See sample table Appendix E.

4.6 Instrument and Control Wiring

In general and where practicable, control and instrumentation wiring shall be designed and installed to minimize any and all electrical noise and transients. All cabling shall be new and continuous for each run; splices are not acceptable. All conductors shall be copper.

All cabling which may be exposed to mechanical damage shall be placed in conduit, wireway, overhead tray, or other enclosures suitable to the Owner. Wires shall have identifying labels or markings on both ends. The labels shall identify the cable tag, and opposite end destination. Each wire in the system must have an accompanied drawing and location reference.

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 as required by the NEC.

Project and PCS control and instrumentation system wiring shall be bundled, laced and otherwise laid in an orderly manner. Where cable is in wiretrays, waterfalls shall be used, as necessary. 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.

Cable insulation material shall be thermoset composition rated for 90˚C during normal operation. Insulation and jackets shall be flame retardant and self-extinguishing and shall be capable of passing the flame test of IEEE Standard 383 or IEEE 1202. Raceway and cable systems shall not block access to equipment by personnel.

Where appropriate, Fiber Optic Cable used for instrument and/or control shall be ruggedized indoor/outdoor breakout, riser rated, orange jacket, four fiber, 50/125um MM gigalink 600 fibers, 2.5 mm, RoHS, standard strip.

4.7 Modular Replacement

The Project PCS, control, batteries and current sensors shall be connected in a manner that enables field replacement. It is expected that most maintenance will be accomplished while maintaining partial service. The physical and electrical arrangement shall permit module replacement with the isolation breaker/contactor closed and the PCS disconnected.

Owner shall not be required to provide additional space or resources to accommodate the battery module replacement or supplementation. Contractor shall reserve the appropriate spacing and clearance per NESC into the design of the Project to accommodate battery module replacement and supplementation.

4.8 Physical Characteristics

The Project shall meet all applicable OSHA, NEC, IEEE, ANSI, and NFPA requirements for electrical and fire safety.

The Project shall be designed to minimize footprint and volume. The Project may also be designed to include subsurface components or modules, provided relevant operating and environmental factors normally addressed for submersible equipment are considered to assure full life-cycle performance requirements are met.

The Project components located outdoors shall be contained within weatherproof, tamper resistant, metal enclosures suitable for mounting outdoors on concrete pads with a minimum NEMA 3R rating. NEMA 3R: Types 3R, 3RX: Rain-tight, sleet-resistant. Indoor or outdoor use. Same protection as Type 1, but adds a degree of protection against ingress of falling dirt, rain, sleet and snow; also protects against damage due to external ice formation. Rust-resistant. The "X" designation indicates corrosion-resistance.

Any enclosures shall be dust tight to at least the NEMA 3R rating, except as designed to allow forced air exchange with the atmosphere.

Project Modules PCS, and controls shall be accessible and removable for replacement. The Project shall be designed to operate with minimal maintenance for at least five years.

A nameplate shall be provided including:

- Manufacturer Name
- Connection diagram
- ESS ratings; Power, energy, voltage, BIL
- Specimen data; serial number, date of manufacture
- The nameplate shall meet the requirements of IEEE C57.12.00

All necessary safety signs and warnings as described in ANSI Z535-2002 (entire series from Z535.1 through Z535.6) shall be included on the building, shelter or each enclosure. All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the building, shelter or each enclosure.

4.9 Cycle Life

The ESS must be designed to achieve a minimum lifetime of 10 years. The energy storage system must maintain minimum capacities of 2 MW and 4 MWH over the life of the 10-year agreement. If the ESS is subject to capacity degradation, the design must accommodate future augmentation or replacement as required to maintain rated capacity, taking into consideration the specified operating profile. See the ESIC technical spreadsheet in Appendix G for cycle life requirements to various depths of discharge over the anticipated ESS lifetime.

The Contractor shall provide a graph or set of graphs that displays the relationship between depth of discharge, discharge energy throughput, operating temperature, C-rate, resting state-of-charge, and other relevant parameters and the corresponding capacity degradation experienced by the ESS.

Cycle counting shall be accomplished by applying a filter for each of the specified depth of discharge levels, or based on other methodology proposed by the Contractor and agreed to by Owner. Contractor shall propose a methodology for tracking all other parameters that effect ESS capacity.

4.10 Battery Management System

As a subcomponent of a Project, a Battery Management System shall be included to manage the operational health of the Project, provide cell-by-cell diagnostics information and assure safe and optimal performance of the ESS as an interconnected asset to the Owner's electrical system. Primary functions include but are not limited to:

- Monitoring:
  - State of Charge
  - State of Health
  - Voltage/Current
    - String
  - Temperature
    - Module Internal
    - Various Ambient

  - Status
  - Energy Throughput
- Maximum charge/discharge current or power
- Balancing
  - Cell voltage
- Warning and alarms
- Internal protective measures
- Logs of operations
- Management of any software versions
- Cyber Security management of the device itself
- Provide data exchange to the Site Energy Controller
- Contribute to functional safety of overall Project

4.11 Power Conversion System

The PCS shall be listed to UL 1741 Supplement A. The PCS shall be capable of operating in all four power quadrants at rated power (2 MVA). Any combination of kW/MW and kVAR/MVAR output that results in the following equation being true: ⟦kVA_rated⟧ =√(⟦kW⟧ ^2+ ⟦kVAR⟧ ^2) and as defined by the inverter P-Q capability curve, provided that at the system level there may be restrictions on reactive power output if the setpoint is chosen to boost system voltage that is already higher than nominal or reduce system voltage that is already lower than nominal.

The PCS shall be a static device (non-rotational) 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. Only commercially proven switch technology and circuit designs are acceptable.

The PCS, in conjunction with the Project control system, 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 Project control system. However, 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 protection device(s) or external protection devices.

All PCS components shall be designed to withstand the stresses associated with steady state operation, transient operation and overload conditions as implied by this Specification. The Contractor shall be responsible to demonstrate that all relevant aspects of overvoltage stresses have been considered.

The PCS system shall include provisions for disconnection on both the AC and DC terminal(s) for maintenance work. Conductor separation must adhere to the requirements of the Owner's Generator

Interconnection Handbook, the Owner's Distribution Interconnection Handbook, or IEEE recommendations. These disconnects shall be capable of being locked open for maintenance work. Any PCS capacitors shall be provided with bleeder resistors or other such means of discharging capacitors to less than 50 volts within five minutes of de-energization per UL1741 requirements.

The PCS or battery system must have DC bus pre-charging functionality or other means of arc mitigation during switching of the DC disconnect devices.

Outdoor located PCS electronic compartments shall be NEMA 4 and the overall enclosure rating shall be NEMA 3R. PCS shall meet IEEE 519 for harmonic content. Total harmonic distortion shall not exceed IEEE 519 requirements.

PCS cooling system shall not be susceptible to particle contamination and require minimal maintenance. The PCS shall be furnished with nameplates or stickers that are suitable for the environment. Nameplates shall be located so as to be visible with equipment installed and operating. Each nameplate shall indicate the following information:

- Nameplate ratings
- Component name
- Manufacturer's name
- Serial number
- Year built (or may be found in a reference document based on serial number)

4.12 Site Energy Controller (SEC)

The Project shall include all necessary software applications and supporting hardware required to meet the specified functional requirements. Software algorithms, external data input capabilities, and user interfaces shall provide for user specified variable input or set point values, as well as external data value streams required by programs directing the Project operations.

The Project shall include the necessary communication and telemetry hardware, and support communications protocols, to effectively provide the required services. No single mode of failure shall result in loss of power to the control and data acquisition module. The control shall include provisions for an orderly and safe shutdown in the absence of utility power.

4.12.1 Operations and Control Functions

The SEC shall be the primary dispatching location for local monitoring and control command functions, and is responsible to perform the following by priority in this order:

- Protect itself (isolate for any internal fault)
- Remain within power constraints (transformer and Project ratings)
- Remain within frequency constraints
- Remain within voltage constraints
- Remain within operating temperature constraints

- Isolate in response to system anomalies
- Charge/discharge Real Power and Reactive Power in response to SEC programs or external commands
- Communicate status and diagnostic data

The SEC shall respond to commands issued remotely or locally, including but not limited to:

- Change Modes (charge, discharge, etc.)
- Startup/Shutdown
- Change Status (enable/disable)
- Reset Alarms
- System Reset/Restart

The SEC shall respond to the following modes of operation:

- Controller must be able to transition from one mode to any other mode without ceasing operation (current source to voltage source mode changes, excluded). Changing of output from an existing inverter setpoint to any other setpoint as a transition step (example, returning inverter to zero output) before executing next command will be considered unacceptable.
- The controller must have the capability to limit system output based on an external signal. This will allow the unit to output to the limit of the circuit at any time. (e.g., if a circuit is rated for 10 MW and the current load is 5.5 MW unit should limit its maximum charge rate to 4.5 MW. Furthermore, we will feed the controlled the current circuit load in a register and it will do the math internally to determine the new system limits.)
- Controller must be able to transition from one setpoint within a given mode of operation to another setpoint within the same mode without ceasing operation. Changing of output from an existing inverter setpoint to any other setpoint as a transition step (e.g., returning inverter to 0 output) before executing next command will be considered unacceptable.
- Controller must be able to accept and validate a given setpoint command prior to executing a given operation mode. For example, if the Owner sends a command for the BESS to discharge at 1.0 MW in constant real power output mode, the controller must be able to validate and accept the 1.0 MW setpoint prior to it initiating constant real power output mode. Setpoint validation will vary depending on the control mode command but may include limits associated with state of charge, facility ratings, ramp rates, system operating conditions, etc.
- Controller must be able to switch from current source mode to voltage source mode and back via a single remote-control point ("VSI Mode"), as well as a local point on the Human Machine Interface (HMI).
- Controller must be able to operate inverter breakers/contactors via remote control points ("Start" equals one is close command for breakers/contactors and "Start" equals zero is open command for breakers/contactors), as well as a local point on the HMI.
- Controller must be able to reset all applicable system alarms via a remote-control point.
- Controller must be able to conduct real and reactive power operations completely independently of one another until the apparent power limit of the asset is reached.

- Controller shall allow for the prioritization of either real power setpoints over reactive power setpoints or reactive power setpoints over real power setpoints once the apparent power limit of the asset is reached. Prioritization shall be indicated via remote commands from the Owner.
- Controller shall allow the operator to "Idle" or "Standby" real or reactive power from the system while still operating the other.
- Controller shall NOT have a real power mode command which ceases any reactive power mode operation or vice-versa.
- Controller shall consider assign a positive sign convention to system real power output information when the system is discharging (real power).
- Controller shall assign negative sign convention to system real power output information when the system is charging (real power).
- Controller shall assign a positive sign convention to system information when the system is injecting reactive power (acting like a capacitor). This should be considered a leading Power Factor (PF).
- Controller shall assign a negative sign convention to system information when the system is absorbing reactive power (acting like an inductor). This shall be considered a lagging PF.
- Controller sign convention for real and reactive power commands shall match the desired convention assigned to system information reporting. In other words, positive real power commands refer to discharging, negative real power commands refer to charging, positive reactive power commands refer to injecting vars, and negative reactive power commands refer to absorbing vars.
- Specific to the Target State of Charge or Energy (SOC) operational mode, the Controller shall ensure the system reaches the commanded SOC setpoint and then not dispatch the system until after the SOC falls outside the commanded SOC deadband.

4.12.2 Permissive Operational States

As stated in the functional requirements, the Owner will permit the use of the Project in specific operational states remote signals. The Project must be able to integrate with the dispatch center to allow for and acknowledge each operational state. A command table must be submitted by the Contractor and approved by the Owner prior to the acceptance of the controller and factory acceptance test.

4.12.3 User Settable Limits

User settable limits shall be provided for the parameters listed below. These limits should have the capability to be changed either through the HMI and/or a remote setpoint. If a limit is reached an alarm or warning should alert the operator to the condition:

- Global Real Power Limit
- Global Reactive Power Limit
- Global Apparent Power Limit
- Mode-Specific Real Power Limit (unique limit for each mode)
- Mode-Specific Reactive Power Limit (unique limit for each mode)

The Site Energy Controller shall enforce whichever limit is most restrictive for the current mode of operation, either the mode-specific limit or the global limit.

4.12.4 Human Machine Interface

A local HMI shall be provided to permit local monitoring and control. All settings must be viewable and settable, statuses viewable, operating parameters viewable, and logs configurable and viewable. Local password protection is required. Different login accounts shall be set up to allow for a hierarchy of operators: (i.e., observer: read, operator: read/write, admin).

Meaningful control buttons and indicating lights shall be provided for monitor and control status and operations. All control and alarm functions available remotely shall also be available locally.

A data entry screen shall be provided in the HMI to allow input of all user settable parameters, such as ramp rates, real and reactive power limits, power factor limits, etc. This data entry screen shall require admin login rights. Display screens shall be developed for each of the control modes. Each screen shall display the mode, setpoint(s), actual value(s), deviation(s) from setpoint, and any applicable limits or configuration parameters.

The HMI shall include alarm screens, including alarm summaries, alarm details, and alarm logging. Alarms screens shall be provided for balance of plant type information (HVAC, fire alarms, UPS, etc.) in addition to energy storage system information.

An Emergency Stop (E-Stop) button or equivalent shall be provided in the HMI to allow the operator to quickly shut down a unit. The E-Stop button shall have the ability to open contactors/breakers to the inverter and batteries isolating the DC and AC potential.

4.12.5 Remote Operations

The Project shall provide a single interface with which the Owner can communicate. All commands, feedbacks, information, statuses, and alarms from all system components or subsystems (fire suppression and/or HVAC included) should be conveyed via said interface. Single interface must have a minimum of four fiber ports and four copper ports or a network switch which provides the specified number of ports.

The SEC shall be able to respond to manual commands that are issued remotely by an external supervisory controller using a secure internet-based protocol. Commands sent to the SEC may come from other applications within a larger Distributed Energy Resource hierarchy.

The Project shall remain functional in the absence or loss of communication from the remote controller. The Project shall continue its current mode of operation for a set time period (variable setting, 15-minute default). On expiration of the time, the Project shall standby.

During an interruption to communications, the remote controller will make repeated attempts to re-establish communications at a set time interval (variable setting, default of five minutes). When communications have been re-established, the Project and remote controller shall make any necessary updates to resume performance.

A "Local/Remote" control function shall be provided in the HMI so that the operator may allow or inhibit remote commands. The SEC shall log the source of each command (i.e., HMI/Operator Name, Remote). The source of the current active command shall also be displayed in the HMI.

4.12.6 Monitoring, Data Logging, Alarms, and Status

Alarms

- Alarms shall be provided for all critical energy storage system parameters (see Appendix E for more details).
- Alarms shall be provided for all critical balance of plant system parameters (see Appendix E for more details).
- The operator shall be able to assign criticality or importance to alarms and filter the alarms so that only the most critical are displayed on the HMI.
- Operator shall have the ability to acknowledge alarms.
- An alarm log with time stamps shall be provided.
- Details or help screens shall be provided for each alarm.
- An alarm matrix shall be provided to show the relationship and hierarchy of all alarms.

The SEC shall provide relevant status information, for feedback to the utility supervisory control system. The telemetry points should include:

- Operation Control
- Operation Status
- System Information
- AC/DC Status
- Counters
- Status
- Device Status and Error Codes (Alarms)
- Data Logging:
  - Log of Operations for one year on-site. Life-of-project duration for off-site log.
  - Historical data and trending for one year on-site for a limited set of parameters as-agreed with the Owner. Life-of-project duration for off-site data.

For full list of required information, please see Appendix E.

4.13 Network Communications

The Project and all its subcomponents required for operation shall be configured to be on its own sub-network, separate from any Owner communications network.

- Communication between the energy storage system and any Owner IP network shall be accomplished using a managed point of interconnection between the Contractor-provided energy storage system and any Owner IP-based network. The Contractor connectivity solution shall use a barrier technical control, such as a firewall. The Contractor shall configure the Contractor barrier technical control to deny IP traffic by default, and allow authorized IP traffic by exception. The Owner shall configure its own barrier technical control between Owner networks and the

Contractor-configured barrier technical control, and shall configure the Owner barrier technical control to deny IP traffic by default and to allow authorized IP traffic only by exception.

- A modern IP-based protocol shall be used for external communications between Owner networks and the Contractor's energy storage systems. Other protocol options shall be implemented only by mutual agreement between the Owner and the Contractor and are subject to Owner's Information Assurance Program.
- A secure, encrypted site to site IP VPN tunnel may be established between the Owner and the Vendor to allow the Vendor remote access to the energy storage system for monitoring and support purposes. The Owner firewall will deny IP traffic by default, and allow authorized IP traffic only by exception. Vendor will provide a detailed list of devices and protocols that require access for remote support.
- The Owner shall provide IP subnet assignments using private RFC 1918 address space for use in the energy storage system network. If required, a separate IP subnet assignment will be provided by the Owner for site to site VPN remote access purposes. If network address translation is required, it is the responsibility of the Vendor to configure translation on their side of the connection.
- Any additional Contractor or Vendor external communications to the energy storage system are prohibited. This includes analog lines, cellular modems, wired or wireless communications circuits, internet connections, or any other connection methods. If the Contractor requires alternate external communications, these must be submitted to the Owner for review. If the Owner grants approval, it is the sole responsibility of the Contractor to provide, install, secure, and maintain. The Contractor shall pay all installation costs and reoccurring charges for approved communications. For cybersecurity purposes, the Owner will not interconnect any Vendor network that has Internet access with any Owner routed IP network or networked device.

  The Project's HMI for control shall be able to be controlled by the Owner electric control centers using a TCP/IP routable protocol specified by the Owner.

- The Project's SCADA and historian information shall be able to be accessed by the Owner electric control centers using a TCP/IP routable protocol specified by the Owner.

Contractor shall provide its proposed network and communications documentation to include identifying all serial and network cables.

The solution shall use wired connections for communications. If the Contractor wishes to include wireless communications in the proposal, these must be submitted to the Owner for review. The Contractor shall provide a list of any proposed wireless communications devices, security methods and encryption standards, the associated protocols, and a list of endpoint devices that would be connected.

Contractor provided communications equipment shall be suitable for the intended purpose and the environment where it is installed. Contractor shall use hardened devices that support extended temperature and humidity where required. For key system communications, the equipment should have built in high availability or redundancy capabilities, or separate redundant devices should be used.

Any Contractor-provided LAN switch implemented as a part of the Project shall have a switch port configured as a SPAN port, to which an Owner network anomaly detection appliance shall be attached to span the traffic to identify and alert on apparent cybersecurity issues.

The proposed solution shall provide communications for any required security and fire alarm systems, including fire and first responders, in compliance with all Applicable Laws and Owner standards. The

solution shall be capable of communicating with Owner-selected Remote Terminal Unit (RTU) via currently-supported protocols and cabling types, as assisted by an Owner Interface.

The solution shall be capable of communicating with the Owner-selected Automated Dispatch System (ADS) Gateway via currently-supported protocols and cabling types, as assisted by an Owner Interface. The solution shall be capable of communicating with the Owner-selected Owner Metering via currently-supported protocols and cabling types for both the systems load and auxiliary load, as needed. The energy storage site metering system shall be implemented to support polling via the Owner's specified protocol, as assisted by an Owner Interface.

The Project shall support selection of control modes between local HMI, remote Owner, ADS, and AGC control sources, as assisted by an Owner Interface. The Project shall be capable of integration with the Owner enterprise control system, as assisted by an Owner Interface. Any Contractor-provided LAN switch implemented as a part of the Project shall have a switch port configured as a SPAN port, to which an Owner network anomaly detection appliance shall be attached to span the traffic to identify and alert on apparent cybersecurity issues.

The Project must be able to interoperate with either a (RTU) local to the site, or a RTU that the Owner may locate at a central location and communicate to over Owner-owned WAN communications for aggregation of multiple sites to a single RIG before transport of data between the Owner and the local utility/transmission owner.

The Project's Owner-facing network and firewall equipment shall be interoperable with Owner Networks LAN switches, routing, and firewalls, to include static routing, MPLS, OSPF, and 802.1q VLAN trunking.

4.14 Information Security

4.14.1 Contractor

Contractor shall design the Project to be hardened against willful attack or human negligence using Cybersecurity industry best practices and incorporating technical controls as applicable to the Project as outlined in the NISTIR 7628 Framework. The reference for these controls can be found through the NIST government publications for the Framework NISTIR 7628 – Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements. A summary of these controls is listed in Appendix G.

4.14.2 Account Management

The Contractor shall design the Project to support integration with the Contractor's centrally managed Active Directory instance. The Contractor's control system solution will authenticate through LDAP or OAuth, as assisted by an Owner Interface.

4.14.3 Application Partitioning

The Contractor shall design the Project to support integration with Role-based Access Controls, as assisted by an Owner Interface. For example, functions necessary to administer databases, network components, workstations, or servers, and typically requires privileged user access. The separation of user functionality from information system management functionality is either physical or logical.

4.14.4 Audit Logging and Reporting Mechanisms

The Contractor shall design the Project to provide logging capabilities. Preferably the logging mechanism is in a standard format like Syslog that can easily integrate with the Owner Security Integration and Event Management system.

4.14.5 Authentication and Authorization Controls

- The Contractor shall design the Project to provide the following authorization controls:
  - Log account access events, such as failed login, login, logout, session timeout.
  - Display an approved system use notification message or banner before granting access to the system that provides privacy and security notices consistent with all Applicable Laws, Executive Orders, directives, policies, regulations, standards, and guidance.
  - Prevent non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures.

4.14.6 Authenticator Feedback

The Contractor shall design the Project to obscure feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. For example, do not display a separate error message for an invalid username versus an invalid password.

4.14.7 Baseline Configuration and Configuration Settings

The Contractor shall provide a checklist of security configuration requirements / system hardening requirements for all IT assets deployed as part of the Project, as assisted by an Owner Interface.

4.14.8 Boundary Protection System

The Contractor shall segment trust zones using a barrier technical control such as a firewall. The barrier technical control shall be configured to deny network communications traffic by default and allow network communications traffic by exception.

4.14.9 Cryptographic Key Establishment and Management

The Contractor shall provide certificates that support at least SHA-2, SHA-1 certificates are not permitted. Wildcard certificates like *.example.com are not permissible and certificates must be for specific (list) of sub-domains. All PKI certificates must support SHA-256 or higher. The Contractor will provide cryptographic keys from a Certificate Authority approved by the Owner.

4.14.10 Device Identification and Authentication

The Contractor shall provide an asset inventory containing all IP addressable devices in the Project. The asset inventory will include the following fields: Device Name, Network Name, IP Address, MAC Address, Building Location, Rack Location, Firmware version / software version, Device Description.

4.14.11 Information Input Validation

The Contractor shall provide a solution that validates user input and network input for malicious content and unstructured data within the Project. For example, user interfaces should not be susceptible to untrusted user inputs.

4.14.12 Information System Backup

The Contractor shall provide the Project with a solution that is scheduled to conduct periodic backups of user and system-level information and protect the confidentiality, integrity, and availability of the backups.

4.14.13 Information system Monitoring

The Contractor shall allow the Owner to monitor network traffic leveraging SPAN ports on switches and routers provided as part of the Project.

4.14.14 Least Functionality

The Contractor shall configure information systems to provide only essential capabilities, open ports, protocols, and services as part of the Project.

4.14.15 Malicious Code Protection

The Contractor shall provide malicious code Endpoint protection software on all assets that support it in the Project and provide a method for updating the software. The Contractor shall configure the Endpoint protection software to perform periodic scans of the information systems and real-time scans of files that are downloaded, opened or executed. The malicious code protection software will block malicious code, quarantine malicious code and send alerts to administrators of the system. Enforced Whitelisting of system software and operation may be considered an alternative to Endpoint protection.

4.14.16 Password-Based Authentication

The information system shall offer provisions for a password-based authentication. These features should include, but are not limited to, the following:

- Enforce password complexity to include case sensitivity, a minimum of eight characters, mix of upper-case letters, lower-case letters, numbers, and special characters.
- Stores and transmits only encrypted representations of passwords.
- Enforces password minimum and maximum lifetime restrictions of specific defined numbers for lifetime minimum, lifetime maximum.
- Prohibits password reuse for 10 generations.
- Allows the use of a temporary password for system logons with an immediate change to a permanent password.
- Employs automated tools to determine if password authenticators are sufficiently strong as related to above criteria of password authentication requirements.

4.14.17 Protection of Information at Rest

As part of the Project, the Contractor shall implement Information Systems that:

- Protects the confidentiality and integrity of information at rest.
- Implements cryptographic mechanisms to prevent unauthorized disclosure and modification of information on information system components.
- Securely stores off-line storage.

4.14.18 Remote Access Policy

The Contractor should leverage a two-factor authentication solution architecture to remotely access the Project, as assisted by an Owner Interface.

4.14.19 Session Authenticity

As part of the Project, the Contractor shall implement Information Systems that:

- Invalidates session identifiers upon user logout or other session termination.
- Generates a unique session identifier for each session with randomness and recognizes only session identifiers that are system-generated.
- Only allows the use of certificate authorities for verification of the establishment of protected sessions.

4.14.20 Transmission Confidentiality and Integrity

As part of the Project, the Contractor shall implement cryptographic mechanisms to prevent unauthorized disclosure of information during data transmission (e.g., VPN Tunnel).

4.14.21 Unique Identification and Authentication

As part of the Project, the Contractor shall provide the means to uniquely identify and authenticate organizational users (or processes acting on behalf of organizational users) such as Multifactor authentication. Shared user accounts shall not be permitted.

4.14.22 3rd Party Assessment

Contractor shall contract information/cyber security scans and penetration tests by an Owner-approved third party security company, prior to Substantial Completion.

The Contractor will provide the Owner with a copy of the original report from the 3rd party security company. The Owner reserves the right to perform its own internal security testing in addition to the Contractor's testing.

Contractor shall develop a cybersecurity plan that addresses and mitigates the critical vulnerabilities inherent in both the hardware and software that comprise the control and data acquisition systems. The

cybersecurity plan will include regular qualified software patches and service packs to Windows and Linux based operating systems, the underlying software and device firmware. The patches will be applied at least every 90 days with an expedited method for highly critical vulnerabilities (Common Vulnerability Scoring System Score of 10).

4.14.23 Portable Media and Laptops

As part of the Project, the Contractor shall disable all mass storage device capabilities for Windows and Linux based servers and workstations (USB drives, SD Cards, CD-ROMs, External Portable HDDs and Floppy disk drives).

Any portable device (or variant) such as process control service laptops will be regularly managed by policy to ensure it is inspected and found to be free from malicious code. Using latest version Endpoint protection with regular updates no older than 30 days. Portable devices will be restricted from connecting to a secondary network while connected to the Process Control network. The Owner may request logs and audit access to review system scans, patching and management tools to ensure compliance.

4.14.24 Unused Network Ports

As part of the Project, the Contractor shall disable all unused network ports on switches, routers and firewalls.

4.15 Containment

4.15.1 Lightning Protection

Provide a UL Master Label lightning protection system for all buildings, shelters and other structures per the requirements of NFPA 780 and UL 96A.

4.15.2 Cooling Systems

The Site temperatures and the effect of temperature on component life shall be considered in developing the thermal design for all components, including the batteries and PCS. There may be several separate heat removal systems to accommodate the particular needs of Project components and subsystems (e.g., PCS, transformers). The heat removal and/or cooling system may include vapor-compression cooling system or other conventional environmental conditioning equipment. Final rejection of all waste heat from the Project shall be to the ambient air.

Sizing of the cooling system shall be sized for end-of-life battery heat loss information. Total battery heat dissipation shall account for all installed batteries including any provisions for battery augmentation throughout the project life.

Air handling systems shall include filters to prevent dust intrusion into the Project. Exterior wall make-up air inlet louver shall be sized to avoid water penetration. HVAC system(s) efficiency and control requirements needs to comply with applicable local and national codes. HVAC system(s) for energy storage cooling shall include three or more stages. Sufficient redundancy shall be considered in the design such that no single component failure will shut-down the system.

HVAC and ventilation systems shall be seismic braced/anchored. All design shall be in accordance with local and national seismic design requirements.

Evaporator coil coating shall be required if outside air is draw-in from the exterior. Indirect waste from the HVAC system(s) shall be disposed per local and national plumbing codes. HVAC/ventilation design shall comply with all Applicable Laws. HVAC/Ventilation shall require interlock to the shelters fires alert system for shut-down.

4.15.3 Fire Protection

The Contractor shall provide fire protection system for the complete ESS system including modification of existing site fire protection system to meet all applicable codes including the 2nd DRAFT release of the new NFPA 855 "Standard for the Installation of Stationary Energy Storage Systems" and the latest approved revision of the applicable local fire protection codes.

EPC contractor shall comply with NFPA coordination, design, installation, commissioning, testing, training and startup requirements. This shall include all other requirements as outlined in this specification. Fire Protection system design shall include, but not be limited to, the following:

- Emergency vehicle access and fire hydrants per applicable local and national codes;
- Hazard Mitigation Analysis (HMA) to defend and gain alignment for the system design with all key stakeholders before the design is finalized (e.g. risk mitigation for runaway prevention);
- Battery containers/ control shelter design in accordance with NFPA requirements for location, separation, materials of construction, ventilation, smoke or flammable conditions detection, fire suppression, communications/alarms, training, commissioning, permitting, and documentation
- The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. The HVAC Engineer shall design and specify startup and testing services to support the interface with the Fire Protection System and ensure that the HVAC is de-energized as designed. Alarms shall clearly annunciate location of detected condition within building or by individual container.
- Startup and testing of the Fire Protection System will be provided by the fire protection contractor in accordance with NFPA requirements.

Contractor will provide the potential combustion products and quantities for the batteries (or other storage media) selected to be used with the ESS system.

If lithium-ion batteries are proposed as the storage medium, the Contractor shall provide an optional price for a lithium ion battery fault detector utilizing an off-gas sensing system that will detect off-gassing at the cell level. This system shall be integrated into the Contractor's control system and/or site controller.

4.16 Station DC System and Uninterruptible Power Supply

The Project shall be equipped with a Station DC system and/or a UPS to power essential functions in the event of a total failure of auxiliary supply systems(s) if required for orderly shutdown. The UPS system shall provide backup support for all control and communication equipment necessary for blackstart and islanded operation. The provided DC system/UPS shall comply with the applicable standards. In no case shall the UPS have less than eight hours of back-up power for power essential functions. Protective relays

shall have no less than 72 hours of backup power. Owner's preference would be to have this UPS function provided by the primary Energy Storage System.

4.17 Energy Storage System Design

The Contractor shall design, furnish and install an ESS that meets all of the requirements of the Agreement, including this Specification.

4.17.1 Cells and Modules (if applicable)

The energy storage shall consist of cells of proven technology designed for the type of service described herein. For the purposes of this Specification, proven technology shall be defined as cells that have been in successful commercial service in similar type applications for a period of time sufficient to establish a service life and maintenance history. Only cells that are commercially available or for which suitable (not necessarily identical) replacement cells (or modules or strings) can be supplied on short notice throughout the Project life will be allowed. Cells shall be listed to UL 1642 and manufacturer must provide UL certificate prior to shipment to Project Site.

The cells may be supplied as separate, individual units or as group of cells combined into modules. Modules shall be listed to UL 1973 and UL 9540A and manufacturer must provide UL certificate prior to shipment to Site.

Cell construction and accessories (as applicable) shall be sealed to prevent electrolyte seepage. Post seals shall not transmit stresses between the cover or container and the posts. Cell terminals and interconnects shall have adequate current carrying capacity and shall be designed to withstand short circuit forces and current generated by the energy storage. Safety features shall be designed into each cell in accordance with UL 1642, UL 1973, and UL 9540A.

DC Contactors will disconnect the string from the circuit during high temperature conditions but will reconnect once the cell temperatures reach an acceptable range and other conditions are met allowing reconnection. Labeling of the cell (or modules) shall include manufacturer's name, cell type, nameplate rating and date of manufacture, in fully legible characters or QR code. Contractor shall provide a list showing all the modules by their unique identification number along with their corresponding physical location within the project site. The unique identification numbers shall correspond to their identification within the Project so to provide easy location of all cells or modules.

The energy storage subsystem as a whole and as individual cells shall be designed to withstand seismic events as described herein. The batteries may consist of one or more parallel strings of cells.

DC wiring shall be sized per NEC Article 310 or based on UL standards and be appropriately braced for available fault currents. Protection shall include a DC breaker, fuse or other current-limiting device on the energy storage bus. This protection shall be coordinated with the PCS capabilities and energy storage string protection and shall take into account transients and the Inductance/Resistance (L/R) ratio at the relevant areas of the DC system. The Project shall operate no higher than 1,500 volts DC.

The Contractor shall provide information on the impact that weak or failed cells have on the life and performance of the entire string. The Contractor shall specify critical parameters, such as temperature variation limits between cells of a string. The Contractor shall provide a means of monitoring critical parameters to ensure the limits are being met.

Cells, wiring, switchgear and all DC electrical components shall be insulated for 2,000 volts DC. The Contractor shall have overall responsibility for the safety of the electrical design and installation of the Project. The Project shall include a monitoring/alarm system and/or prescribed maintenance procedures to detect abnormal cell conditions and other conditions that may impair the ability of the Project to meet performance criteria.

The energy storage monitoring system shall be capable of balancing the voltages across cells automatically and independently without any input from the operator or the SEC. Cell monitoring system shall be specified so as to alert the proper personnel in a timely manner that an abnormal cell condition exists or may exist. Abnormal cell conditions shall include over- and under-cell voltage. Temperature is not expected to be monitored at the individual cell level.

The monitoring/alarm system will record data on the number and general location of failed modules, to expedite maintenance and cell replacement. This data shall be stored in non-volatile memory. Such monitoring/alarm systems shall be integrated into the overall control system.

The Project shall include racks or shall consist of stackable modules of batteries. Aisle spaces shall be set to permit access for equipment needed for easy removal and replacement of failed modules. The lengths and widths of aisles shall conform to all applicable codes and facilitate access by maintenance personnel. As applicable, the racks shall provide sufficient clearance between tiers to facilitate required modules maintenance, including modules testing and inspection, and replacement.

Rack-mounted modules shall have all connections located on the front of the enclosure or module. Modules shall not be required to be removed from the racks during regular maintenance. All racks and metallic conductive members of stackable modules shall be solidly grounded. Racks shall be seismically designed based on the requirements of Section 1.4 and shall include means to restrain cell movement during seismic events. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.18 Medium Voltage Switchgear

Metal-enclosed switchgear shall be designed, constructed and tested per IEEE C37.20.3. Metal-clad switchgear shall be designed, constructed and tested per IEEE C37.20.2. Design test results shall be provided to the Owner prior to shipment to the Site.

4.18.1 Field Tests

Contractor shall:

- High-potential test each breaker in accordance with IEEE C37.20.2, Table 1 and part 6.5. Apply test voltage to each pole of the breaker for one minute.
- Test and record contact resistance on each phase from bus to load terminal through a closed breaker.
- Record operation counter reading.
- Perform vacuum integrity test.

The medium voltage switchgear lineup shall be rated to continuously carry nominal Project generation. The lineup shall contain power metering and voltage transformers, fused switches and circuit breakers as necessary to collect and interconnect full plant generation.

Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays and a 120/240 volt Control Power Transformer. The Control Power Transformer shall be fused and able to disconnect. The Control Power Transformer shall be sized to supply the expected continuous load, with approximately 20 percent margin for future load growth. The transformers shall be air-cooled, dry type, with a 150°C rise. Alternatively, site DC backup power may be used.

Switchgear shall be provided with a metering section containing provisions for utility meters. Consistent with the Owner's Electric Distribution System Interconnection Handbook, the metering section includes cable pull sections, bus bars for metering CT/PT insertion, disconnect switches, a metering panel, a meter socket(s), and accommodations for test switches/test blocks. A set of visible disconnect switches, or rack-able breaker, shall be placed directly on the line side of each metering section as well as a set of disconnect switches for the metering PTs (accessible by Owner personnel only) per the Owner's service requirements. In addition, a set of disconnect switches shall be placed on the load side of the meter or at the point of generator output. Disconnect switches and rack-out breakers must accommodate locking devices to allow the Owner to lock-out services or net-generation points when necessary.

Protective relaying, metering, and control parameters shall be in accordance with the Owner Electric Distribution System Interconnection Handbook and reviewed and approved by Owner prior to construction. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.19 3P, Liquid-Filled or Dry-Type Pad-Mount Transformer

The nominal high-side voltage shall be 12.47 kV, unless noted otherwise by the Owner. Transformer low voltage windings shall be per inverter manufacturer's recommendations. Percent impedance voltage shall be according to the inverter manufacturer's recommendation. Transformers shall be rated for continuous operation of the inverters.

Transformers shall be configured as Wye high side, Delta low side. This transformer will also require a high side neutral (HO) bushing with ground strap connected to the neutral. The aux transformer will require an electric meter socket. This can be designed in to the transformer or a pedestal with a meter socket can be used to meter site aux load. Transformers are required to have load interruption capabilities on the low side to isolate the energy storage equipment (inverters, storage media, etc.).

Liquid filled transformers shall be designed, constructed and tested in conformance with IEEE C57.12.00. Liquid filled transformers shall contain a UL-listed and Factory Mutual Global Approved less-flammable dielectric coolant meeting the requirements of NEC Section 450-23 and the requirements of the National Electrical Safety Code, Section 15. Transformer shall be suitable for indoor or outdoor use as applicable. Routine test results shall be provided to the Owner prior to shipment to the Site. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.19.1 Field Testing

- Verify nameplate data.
- Coordinate and perform instrument transformer tests on CTs with transformer assembly.
- Winding Tests:
  - Transformer Turns Ratio (TTR) at all no-load taps.

  - Megger winding to ground.
  - Megger winding to winding.
  - Set high voltage taps at positions determined by Engineer.

- Check and measure equipment ground; ground shall not be more than one ohm.
- Check insulating fluid for clear or pale amber color and report any variance to the Owner. Other colors may indicate contamination from decomposition of insulation, foreign material, carbon, or other substances.
- Test oil samples from each transformer with standard AC test in accordance with ASTM D1816. Notify the Owner if breakdown voltage is less than 30 kV.
- Check liquid level in tanks, and in bushings of the liquid-filled type, and check nitrogen content in inert gas sealed oil preservation systems.
- Check that all valves are open between the transformer tank and cooling equipment.
- Check operation of cooling equipment and cooling controls before energizing transformer.
- Check calibration of pressure relief device, top oil temperature relay, and hot spot temperature relay.
- Pressure test the sudden pressure relay in accordance with the manufacturer's instructions to verify proper operation of device and electrical contacts.
- Alarm Sensor Testing: induce the device to operate with proper input medium (heat, cooling, pressure, vacuum, voltage, current, etc.) and verify operation of the device at the correct input medium level by monitoring the output contacts with an ohmmeter.
- Annunciator Testing: check each unit of annunciators by closing or opening the trouble contact and observing operation of control board.
- Check all annunciator lamps, bell cutoff, and reset operation.
- Test all gauges including level, temperature, and pressure gauges.

No Load taps labeled per IEEE Std C57.12.34. Full-capacity taps in high-voltage winding:

- Two 2.5% taps above rated voltage.
- Two 2.5% taps below rated voltage.
- Transformer compartments shall have provisions for padlocking.
- High-voltage compartment shall contain terminations for dead-break elbows, and provisions for entrance of multi-conductor high-voltage, insulated, shielded, power cable. Provide terminations with stress relief devices.
- Transformer shall be equipped with a load-break switch that is oil immersed in transformer tank. The handle shall be located on the exterior tank wall. The switch shall be operable without exposure to any live circuits.

Include accessories as follows:

- Dial-type thermometer with contacts for high-temperature warning and alarm levels

- Magnetic liquid level gauge with alarm contact for low level.
- Pressure/vacuum gauge with alarm contacts.

4.20 Dry Type Transformers

Dry type transformers shall be designed, constructed and tested in conformance with IEEE C57.12.01. Dry type transformers shall be ventilated dry-type cast coil, Class AA suitable for indoor or outdoor use as applicable. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.20.1 Field Testing

- Verify nameplate data.
- Winding tests:
  - Transformer Turns Ratio (TTR) at all taps.
  - Megger winding to winding.
  - Megger winding to ground.
- Check equipment ground to assure continuity of connections. Notify the Owner if ground is more than one ohm.
- Check electrical neutral of the transformer. This connection shall be a copper wire connection to the station ground grid.
- Check for proper operation of the winding temperature gauge and cooling fans.
- Set high voltage taps at positions determined by Engineer.
- Check connections for tightness; clean out dust and other foreign material.

No Load taps labeled per IEEE Std C57.12.34. Full-capacity taps in high-voltage winding:

- Two 2.5% taps above rated voltage.
- Two 2.5% taps below rated voltage.

4.21 Raceways

4.21.1 Conduit

- Contractor shall install all conduit, bends, accessories, fittings, junction boxes, mounting hardware, etc., to produce the complete system.
- Conduit shall be sized and installed in accordance with the NEC.
- In general areas, Electrical Metallic Tubing can be used for all feeders hidden from view above ceilings and in walls. Electrical Metallic Tubing fittings shall all be compression-type fittings. Set-screw fittings shall not be utilized.

- Flexible Metal Conduit or Liquid-tight Flexible Metal Conduit shall be used for connections to motors, transformers, machinery, lighting, and for other equipment subject to vibration.
- Rigid Metal Conduit or Intermediate Metal Conduit shall be used as allowed in the NEC.
- Plastic conduit, elbows, couplers and other fittings for underground application shall be Schedule 40 PVC, UL or ETL Listed. Fabrication, testing, and installation shall be per NEMA TC-2. Direct buried conductors will not be allowed. Each underground conduit package shall include at least one spare conduit.
- Threaded or compression fittings shall be used with all raceway types. Set-screw fittings are not permitted.
- All conduit shall be sealed.

4.21.2 Tray

- Tray shall be fabricated, tested, and installed per NEMA VE1, NEMA VE2, and the NEC.
- Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063 and all fabricated parts shall be made from Aluminum Association Alloy 5052, in accordance with ASTM B221 and ANSI H35.1.
- Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
- Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All hot-dip galvanized after fabrication cable trays and components must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc to mitigate damage to cables and/or injury to installers.
- Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors, then hardware shall be Type 316 stainless in accordance with ASTM F593 and F-594.
- Any exterior tray shall include a cover.
- All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.22 Medium Voltage Cable

- Cable shall be listed to UL 1072 and adhere to NEC requirements.
- Cable furnished shall be suitable for installation in underground ducts and conduits, trays, underground structures, and in outdoor applications of direct underground burial or for use in suitable supported aerial applications. Cable shall be rated for wet and dry locations.
- Insulation shall be thermosetting compound with minimum ratings for normal conductor temperatures of 90°C, 140°C for emergency operation condition, and 350°C for short circuit conditions.

- Cable shall be tested at the factory and reports delivered to the Owner prior to shipment. Once test results are provided to the Owner, it will have five business days to review testing reports. Contractor shall not ship cables until the Owner approves the test reports or the review period expires.

4.22.1 Field Tests

- Field high potential test in accordance with NEMA WC 74 (ICEA S-93-639), Table F-1, DC Test Voltages After Installation and NETA ATS, Table 100.6, Medium-Voltage Cables Acceptance Test Values, as follows:

		DC TEST VOLTAGE (KV)	
RATED VOLTAGE (KV, PHASE-PHASE)	CONDUCTOR SIZE AWG OR KCMIL	100% INSULATION	133% INSULATION
2,001 – 5,000	8 – 1,000	28	28
2,001 – 5,000	1,001 – 3,000	28	36
5,001 – 8,000	6 – 1,000	36	44
5,001 – 8,000	1,001 – 3,000	36	44
8,001 – 15,000	2 – 1,000	56	64
8,001 – 15,000	1,001 – 3,000	56	64
15,001 – 25,000	1 – 3,000	80	96
25,001 – 28,000	1 – 3,000	84	100
28,001 – 35,000	1/0 – 3,000	100	124
35,001 – 46,000	4/0 – 3,000	132	172
46,001 – 69,000	4/0 – 3,000	N/A	195

- The initially applied DC voltage shall be not greater than 3.0 times the rated AC voltage of the cable.

- The duration of DC voltage test shall be 15 minutes.

- Do not test cables with an AC test set. Disconnect from all equipment during testing. Testing cable on the reel will not be acceptable. Perform tests after installation, but before final connection to equipment. Make high potential tests between each conductor and shield, or between conductor and armor with shield or armor grounded.

4.23 2.0 kV Cable

- Cable shall be listed to UL 44 and adhere to NEC requirements.
- Cable shall be rated for use in conduit, underground ducts, and cable tray.
- Insulation shall be thermosetting compound with minimum ratings for normal conductor temperatures of 90°C.
- Field Tests
  - Megger insulation resistance testing is required prior to energization.

4.23.1 Field Tests

- All field tests shall be performed by a certified third-party testing company.

- In addition to the tests specified previously, the following tests shall be conducted:
  - Low voltage breakers 100A and greater shall be trip tested.

5.0 APPENDIX A APPLICABLE STANDARDS AND CODES

NO.	STANDARDS	CODE
1	ANSI/IEEE C2	National Electric Safety Code
2	IEEE 519	IEEE Recommended Practices and Requirements for harmonic Control in Electrical Power Systems
3	IEEE 1547	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
4	IEEE 1547.1	Standard Conformance Test Procedure for Equipment Interconnecting Distributed Resources with Electric Power Systems
5	IEEE 1547.2	Interconnecting Distributed Resources with Electric Power Systems
6	IEEE 1547.3	Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
7	ANSI Z535	Product Safety Signs and Labels
8	ANSI C57/IEEE	Transformer Standards, whenever applicable
9	ANSI C37/IEEE	Surge withstand capabilities, whenever applicable
10	UL 1642/IEC 62133	Applicable sections related to battery cell safety, where applicable
11	UL 1741	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
12	NFPA 704	Standard System for the Identification of the Hazards of Materials for Emergency Response
13	UL 1778	Underwriters Laboratory's Standard for Uninterruptible Power Systems (UPS) for up to 600 Volts AC
14	UL 1973	Standards for Batteries for Use in Light Electric Rail Applications and Stationary Applications
15	UL 9540/9540A	Standard for Energy Storage Systems and Equipment
16	Electric Tariff Rule 21	Generating Facility Interconnections
17	NISTIR 7628	Guidelines for Smart Grid Cyber Security
18	NEC	National Electric Code
19	NESC	National Electric Safety Code
20	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
21	CAA	Clean Air Act and Amendments
22	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
23	EPA	Environmental Protection Agency regulations
24	FAA	Federal Aviation Administration regulations
25	FERC	Federal Energy Regulatory Commission regulations
26	FPA	Federal Power Act
27	RCRA	Resource Conservation and Recovery Act
28	SDWA	Safe Drinking Water Act
29	SWDA	Solid Waste Disposal Act
30	TSCA	Toxic Substances Control Act
31	ADA	Americans with Disabilities Act
32	MBTA	Migratory Bird Treaty Act
33	CWA	Clean Water Act
34	ANSI	American National Standards Institute
35	IEEE	Institute of Electrical and Electronics Engineers
36	NEMA	National Electrical Manufacturers Association
37	ASTM	American Society for Testing and Materials
38	ASME	American Society of Mechanical Engineers
39	IEEE 1881	Standard Glossary of Stationary Battery Terminology
40	IEEE 519	Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

NO.	STANDARDS	CODE
41	**IEEE 142**	Recommended Practice for Grounding of Industrial and Commercial Power Systems
42	**IEEE 242**	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
43	**IEEE 2030.3**	Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications
44	**EPRI 3002009313**	Energy Storage Integration Council Energy Storage Test Manual 2016
45	**IEEE 1881**	Standard Glossary of Stationary Battery Terminology
46	**Owner S-76**	Below Grade Substation Standards
47	**MESA**	Open Standards for Energy Storage
48	**NFPA 855**	Standard for the Installation of Stationary Energy Storage Systems
49	**OSSC**	2014 Oregon Structural Specialty Code
50	**International Building Code**	2012 International Building Code
51	**ACI-318**	American Concrete Institute 318-11
52	**AWS**	American Welding Society D1.1 Structural Welding Code - Steel

6.0 APPENDIX B CONCEPTUAL ONE-LINE DIAGRAM

(Insert proposed SLD)

7.0 APPENDIX C ESS FACTORY ACCEPTANCE TESTING PROCEDURE

8.0 APPENDIX D STATE MATRIX

		STANDBY	RUN	CURRENT SOURCE ENABLE	SYNC REQUEST	BLACK START ENABLE	INVERTER READY	INVERTER RUNNING	ISLAND READY	SYNCH READY
1	Standby	1	0	0	0	0	1	0	0	0
2	Island	1	1	0	0	0	1	1	1	0
3	Synch request	1	1	0	1	0	1	1	1	1
4	Black Start	1	1	0	0	1	0	0	0	0

9.0 APPENDIX E SCADA INTERFACE

Overview

The following is information of the data objects being used by the Owner for the purpose of controlling and monitoring storage systems via a communications gateway. Contractor will appropriately deploy or provide an interface which implements a TCP protocol. Additionally, Contractor will implement multiple points list, simultaneously, including Owner Points List as specified below.

Note the alarms list for each system has not been listed, as systems provide a multitude of alarms. In all cases, the complete set of all possible alarms must be conveyed via alarm word points at each level, System and Subsystems (Inverters and Energy Storage Banks). Each bit of a given word must be mapped to a single alarm (fault or warning). Multiple alarms words can be utilized at every level if the number of alarms exceed the number of bits available in a single alarm word.

Alarm words at the System level should have a single bit representing the presence of alarms on each subsystem (Inverter or Energy Storage Bank) that make up the ESS.

Consider a System comprised of two inverters and two energy storage banks. Energy storage bank one and inverter two each have a single active alarm present. The System level alarm word should have a bit for each of the subsystems, in this case, two inverters and two energy storage banks, representing the existence of present alarms. If the last four bits (28-31) were reserved for this (one for each subsystem), the other 28 bits are available to represent System level alarms.

It should be also noted that any other device capable of generating alarms within the ESS should have its alarms passed to the Owner's gateway via the same, single interface described in this section. Any resettable alarms, for any device capable of generating alarms, must be able to be reset via the same, single interface, as well.

Data Object List

Inputs and outputs are broken down into categories and subcategories. The Owner considers ESS to be distinct based on their aggregate, head-end controller. For example, if there are separate head-end controllers within a given designated area, points belonging to one of these systems will follow the Gateway naming structure:

[SES][Head-end Controller/System number]_[Category abbv.]_[Point Name]

Category abbreviations are as follows. If more than one category is defined, the category abbreviation will come first, followed by a number starting from 1 and going up sequentially. All names and sequence number assignments are managed by the Owner as part of system deployment planning and provisioning.

Example:

SES1_SYS_CHRG_KW_LIMIT

SES2_INV1_AC_BRKR_STATUS

When being defined at the Historian, the following nomenclature will be followed:

[Designated area abbv.]_[Gateway Point Name]

Points of different types are expected to follow standard units, signs, and data sizes. The tables shown below provide a guide to be followed when reporting data via the Owner interface. Table F.3 and supplementary material will indicate the expected units for all points. Notice units are generally specified within point names. If there are questions around the configuration of a given data point, consult the tables below and then reach out to the Owner for further clarification.

Points with the suffix "_OUT" are control/command points being issued from the Owner to the head-end controller

Points with the suffix "_FB" are confirmations of all control/command points being sent from the Owner to the head-end controller. The Contractor must echo received control/command points from the Owner back to the Owner, so it is understood whether the head-end controller has received them.

Points are split up into Analog Inputs (AI), Binary Inputs (BI), and Analog Outputs (AO). All specified points take the perspective of the Owner. For example, Analog Inputs are Inputs to the Owner.

TABLE F.1 EXPECTED UNITS, SIGN CONVENTION, AND SIZE

POINT TYPE	UNITS	UNSIGNED/SIGNED TWO'S COMPLEMENT	INTEGER/FLOAT
Real Power	kW	Signed Two's Complement	Float
Reactive Power	kVar	Signed Two's Complement	Float
Amperes	A	Signed Two's Complement	Float
Frequency	Hz	Unsigned	Float
AC Voltage	kV	Unsigned	Float
DC Voltage	kV	Unsigned	Float
Real Power Ramp Rate	kW/s	Signed Two's Complement	Float
Reactive Power Ramp Rate	kVar/s	Signed Two's Complement	Float
SOC	Percentage	Unsigned	Float
Energy	kWh	Unsigned	Float
Power Factor	Decimal	Signed Two's Complement	Float
Temperatures	Celsius	Signed Two's Complement	Float
Cell Voltage	V	Unsigned	Float

10.0 APPENDIX F CONTROL SYSTEM ACCEPTANCE TEST

11.0 APPENDIX G ESIC TECHNICAL SPECIFICATION SPREADSHEET

12.0 APPENDIX H SITE SPECIFIC INFORMATION