

SAN DIEGO GAS & ELECTRIC COMPANY

**Schedule A**

**Technical Specification**

**Battery Energy Storage Project**

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**SCOPE**

This Project Technical Specification (“Specification”), including Appendices, comprise or constitute the requirements to design, fabricate, ship, assemble, test, startup, commission, warrant and make ready for service fully functional battery energy storage systems complete with accessories. This Specification defines specific engineering and operating requirements for the Project that is intended for installation on SDG&E’s electric system. The Project is generally envisioned to be designed to be located in a restricted access setting and configured to meet applicable standards required of other SDG&E equipment with respect to safety, operations, maintenance and environmental impact.

1. **CONFORMANCE TO SPECIFICATION**
   1. **Applicable Documents**

Except as modified herein, the Project , including the batteries, power conversion system, and site energy controller shall be designed, manufactured, and tested in compliance with the latest revision of the applicable standards of ANSI, IEEE, NEC, CPUC General Orders, NEMA, OSHA, ASTM, ASME, CBC, and the California Division of Industrial Safety Regulations. See Appendix B for applicable Standards and Codes.

* 1. **Safety**
     1. The Project must be compliant with IEEE 1547,UL 1642, UL 1741 and UL 1973 as appropriate. Systems must be able to protect themselves from internal failures and utility grid disturbances. As such, systems must be self-protecting for AC or DC component system failures. In addition, systems must be able to protect themselves from various types of external faults and other abnormal operating conditions on the grid.
     2. Project must be compliant with California Fire Code (CFC) Section 608 and California Department of Industrial Relations General Industry Safety Orders Section 5185.
     3. Systems must be designed to be in compliance with applicable safety standards with regard to construction and potential exposure to chemicals and with regard to module or enclosure resistance to hazards such as ruptures and exposure to fire.
     4. Systems must be seismically qualified in accordance with IEEE 693, High Seismic qualification level.
     5. For all Project equipment, the Contractor shall provide information on all known or anticipated safety issues related to the equipment, including appropriate responses on how to handle the energy storage system in case of an emergency, such as fires or module ruptures.
     6. Systems must be designed such as to minimize risk of injury to the workforce and public during installation, maintenance, and operation.
     7. Visual and audible fire alarms should be included as necessary to ensure safety.
  2. **Environmental Requirements**
     1. The equipment will be installed in SDG&E’s local resource area. The environment may contain salt air, ocean fog, prolonged heat or cold and seismic activity.
     2. The Project shall be designed for proper operation without de-rating for the following conditions and limits:
        1. Ambient temperature range compatible with the Site.
        2. Zero gas emissions during normal operating conditions.
        3. Noise produced by any Project operation shall comply with applicable local noise codes.
        4. Systems must be designed to minimize the risk to the environment including land contamination or disturbance (footprint), water contamination or diversion, and air emissions.
        5. Contractor must provide sufficient information specific to their particular product to facilitate utility personnel training and communications with emergency response and environmental agencies. Safety Data Sheets (SDS) shall be provided as applicable.
  3. **Seismic**
     1. SDG&E's system is located in an active high seismic zone. The equipment shall be qualified according to the requirements of IEEE 693-2005 and shall meet the requirements of the high qualification level. Accessories and the mounting of accessories shall be designed in accordance with the latest revision of IEEE 693. This equipment shall be designed for a High Seismic Performance Level.
     2. Anchoring provisions to the foundations of the energy storage system shall be the responsibility of Contractor.
  4. **Reserved**
  5. **Reserved**
  6. **Specification Interpretation**
     1. The Contractor of the proposed equipment, if in doubt as to the true meaning of any part of this Specification, or finds discrepancies in or omissions from said Specification, may submit his request for a written interpretation or correction thereof. Any request for a written interpretation should be made to SDG&E Representative.
     2. Any interpretation or correction of said Specification will be given in writing by SDG&E Representative.

1. **GENERAL REQUIREMENTS**
   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 the drawings or Specification. All parts shall be made accurately to standard gauge when possible so that renewals and repairs may be made when necessary with the least possible expense.

* 1. **Design and Material**
     1. All materials used in this equipment 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. All material installed for final commissioning external to the battery containers shall be consistent with existing SDGE stock (e.g. conduit size, transformer model, cable size and etc.).
  2. **Review Drawings**
     1. The Contractor shall provide electronic Printable Document Format (PDF) one (1) computer-aided design (CAD) file in AutoCAD .dwg format for each type of energy storage system required by this Specification for SDG&E’s review. The review drawings shall be forwarded as specified in the milestone schedule, and shall 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 designs comply with these specifications, the Contractor shall submit to SDG&E design review drawings and documentation at the 30% and 90% completion levels. The review drawings shall include, but not be limited to the following design activities: Site development, footing design, conduit, grounding, shelter and/or container design, 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 may include equipment arrangement drawings, one-line diagrams and design criteria documents.

SDG&E’s review of drawings will be limited to a general review for compliance with the specification. Drawings will not be reviewed for technical correctness or design concept. The Contractor shall continue with design work while preliminary drawings are being reviewed.

SDG&E shall have the right to require the Contractor to make design alterations for conformance to the design requirements of these specifications without additional costs to SDG&E. 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. 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 SDG&E.

The Contractor may submit for review multiple packages of final drawings ready for construction (90% review). 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.

A final set of signed “Issued For Construction” drawings shall be available on-site before construction may proceed. All construction issue drawings shall be signed and stamped by a California registered professional engineer involved in the Project. Approved electronic registered professional engineer stamps shall be provided for electronic issues.

* + 1. The following information shall be shown on each drawing submitted:
       1. Contractors name.
       2. SDG&E contract and release number
       3. SDG&E equipment number if indicated in the contract or Contractors equipment number if not indicated in the contract.
       4. Description of drawings (Title).
       5. Latest revision and date.
    2. Drawings shall be provided for each energy storage system, which clearly indicate the physical parameters, electrical characteristics, and auxiliary equipment. These drawings shall include, but are not limited to, the following:
       1. Nameplate system drawing to be located on the doors of containers, equipment, or cabinets.
       2. Outline drawing including the following:
          1. Assembly of principal components, inverters, control cabinets, parts and accessories.
          2. Power requirements for all control and auxiliary equipment.
          3. Shipping center of gravity for each container or major equipment – shown on two (2) views
          4. Installed center of gravity for each container or major equipment – shown on two (2) views
          5. Centerlines for external conduit and grounding cable connections.
          6. Projected floor space for container systems, including air conditioning units mounted on the side.
          7. Height of components/container from floor level to top of components/container’s highest non-removable point.
          8. Weight of the components and/or container.
          9. Total weight of assembled system including container.
          10. Manufacturer, catalog number, of all major accessories used in the system.
       3. Structural supporting base (foundation) drawings for all separately mounted equipment, control shelter, or container including anchor details and locations completely detailed and dimensioned from equipment centerlines.
       4. Control elementary wiring diagrams, with cross references for checking and verifying all of the control circuit and wiring diagrams, along with the terminal designations for termination of field wiring of all equipment.
       5. Assembly drawing showing piece marks of all components disassembled for shipment.
       6. Communications and control diagrams
       7. Control shelter arrangement and structural design drawings
    3. Within five (5) working days after receipt of the drawings by SDG&E for review, reviewed drawings will be returned to the Contractor. If required in the opinion of the SDG&E’s Representative, or if requested by the Contractor, a design review meeting will be held in SDG&E’s offices with the Contractor’s engineer within one (1) week following return of the reviewed drawings to the Contractor. Contractor shall be provided with at least one (1) 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.
    4. 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. SDG&E review status given to a drawing will be one of the following: “No Comments”, “Furnish as Corrected” or “Correction Required”. Review by SDG&E 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 Specification.
    5. If a drawing is designated “No Comments”, the Contractor may proceed with the work covered by the drawing.
    6. 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 corrections shown and submit electronic copies of the revised drawing to SDG&E. If paper copies are requested, they shall follow the delivery of such electronic copies.
    7. If a drawing is designated “Correction Required”, the Contractor shall revise the drawing to comply with the requirements of the Contract and resubmit electronic copies of the revised drawing and related CAD file for review before proceeding with the work covered by the drawing.
  1. **Record Drawings**

The Contractor shall furnish record drawings to reflect any changes made during or after installation and commissioning of the Project . One (1) set of revised certified drawings on a CD and one (1) set of marked up paper print drawings all with a new revision number shall be forwarded within four (4) weeks from successful installation and commissioning. A transmittal letter shall accompany the mailing itemizing the revised drawings.

* 1. **Instruction Books**
     1. No later than four (4) weeks from the date of commissioning, the Contractor shall furnish two (2) complete identical set of detailed instruction books in both print and digital (Adobe .pdf) formats for each energy storage system furnished under the Specification. These books shall be accompanied by a letter of transmittal and shall 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 equipment. The illustrated parts shall be numbered for identification. Additionally, these books shall contain instructions and test procedures for integrating the Project into SDG&E’s control and monitoring computer networks. All information contained therein shall apply specifically to the equipment 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.
     2. SDG&E will inform the Contractor six (6) weeks after receipt of the instruction books either that they are “approved” or “approved as shown”. If they are “approved”, 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 SDG&E. The corrections shall be promptly incorporated in the instruction books and a total of four (4) complete, identical sets of such revised instruction books shall be furnished to SDG&E in both print and digital formats.
     3. One (1) additional, identical instruction book shall be kept in control shelter
  2. **Study Reports and Calculations**

The Contractor shall submit all design study, simulation and field test reports to SDG&E in a timely manner. These reports shall contain assumptions, study methods, results, significant findings and conclusions.

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

* + 1. **Earthquake & Wind Loading Calculations:** The Contractor shall provide earthquake and wind loading calculations for all critical equipment. Critical equipment is defined as any equipment required for the full range of operation for the Project.
    2. **Seismic Qualification Report:** A seismic qualification report shall be prepared in accordance with the requirements of IEEE 693.
    3. **Grounding System Study:** The Contractor shall perform studies to determine the parameters for the Project grounding system. Such study shall identify step and touch potentials, as applicable. The grounding system for the Project may be connected to the ground grid for the adjoining substation. Connections to and routing of ground cables to connect the ground grid of the adjoining substation shall be provided by the SDG&E.
    4. **Electrical Studies**: The Contractorshall provide electrical studies as required to determine control response and settings, including load flow, short circuit, ampacity, and arc flash analysis.

For the purposes of the system electrical studies, the Contractor shall provide inputs data for an accurate power flow and dynamic simulation model of the Project compatible with SDG&E’s database and software

* + 1. **Relay and Control Settings:** The contractorshall provide complete documentation of all protective relay and Project control settings. Such documentation shall include all calculations and coordination curves used in the development of the settings.
  1. **Testing and Test Reports**
     1. The Contractor shall, within 30 days prior to any on-site testing, submit a Master Test Plan and Procedures indicating the order in which the tests will be conducted and the test method being used along with required instrumentation for SDG&E approval.
     2. The Contractor shall furnish, at the Contractor’s own expense, necessary facilities and test equipment for the required tests.
     3. The Contractor shall notify SDG&E not less than two (2) weeks in advance of the day when:

* + - 1. Manufacture, fabrication and integration starts for the batteries, inverters, controls and assembled containers of each major deployment.
      2. The batteries, inverters, controls and assembled containers and other major components allocated for the each major deployment are ready for testing and inspection prior to packaging for shipment.
    1. Should SDG&E elect to waive the right of inspection, or of witnessing tests, and accept certified test reports instead, SDG&E will notify Contractor no later than three (3) business days ahead of the scheduled inspection or test.
    2. Witnessed factory tests at AES deployment center shall be made in the presence of SDG&E personnel. The test procedures shall be subject to review and acceptance by SDG&E prior to arrival at testing location. The Contractor shall bear all costs of such testing except for the compensation and expenses of SDG&E’s personnel. If scheduling such tests causes schedule delays, then said delays will be accommodated on a day for day basis.
    3. Four (4) copies of the certified reports of all tests shall be furnished to SDG&E in digital and print formats for review. SDG&E will inform the Contractor within one (1) week 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. In addition to written test reports required for each piece of electrical equipment tested, Contractor shall also provide the electronic files produced by the test equipment
  1. **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 Project equipment.

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 and IEEE standards and guides. 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 has the responsibility to furnish the test reports and certify that the necessary testing has been performed.

* + 1. **Factory 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.

* Capacities, Amphour and Watthour
* Efficiencies
* As applicable, maximum noxious and toxic material release rates

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.

* + 1. **Factory Testing of the PCS and Control System**

The Contractor shall develop and submit a factory test plan. As a minimum, sufficient tests shall be conducted to demonstrate that all controls, protective functions and instrumentation perform as designed and is 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 Power Conversion System (PCS) is capable of synchronizing with, and operating in parallel with the utility connection.

The Contractor shall work cooperatively with SDG&E to develop a formal FAT Plan.

2.8.3 **Overall System Tests**

The Contractor shall demonstrate that all aspects of the proposed PROJECT integrate and coordinate as intended. This may be accomplished on a per container basis. At a minimum, the contractor shall demonstrate that all control and management systems, including but not limited to, all levels of battery management system, PCS controls, and overall site controls, interact as intended.

The Contractor shall work cooperatively to develop a formal Overall System Test Plan.

**2.8.4. 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 system through the term of the Long-Term Services Agreement shall be deemed an extension of the performance verification tests.

Actual operating experience will be documented through Contractor 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 SDG&E at other locations.

**2.8.5. Other Compliance Tests**

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

* + Broadband frequency signal strength and noise voltage
  + Harmonic voltages and currents
  + Audible noise measurements
  1. **Spare Parts**

If applicable, the instruction book will list the required spare parts to be furnished with the energy storage system. Each spare part shall be interchangeable with, and shall be made of the same material and workmanship as the corresponding part included with the product furnished under these Specifications.

* 1. **Special Tools**

The Contractor shall furnish a complete set of any special tools, lifting devices, templates and jigs, which are specifically necessary for installation and/or maintenance of the energy storage system. Any accessories normally furnished with this system required as necessary for satisfactory operation thereof, and not specified herein, shall also be furnished by the Contractor. All tools furnished shall be new and plainly marked for identification. One (1) complete set shall be furnished for the Site.

* 1. **Cleaning and Painting**

All weatherproof enclosures shall be thoroughly cleaned of rust, welding scale, and grease, and shall be treated to effect 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 (2) coats of paint of specified color and type. Contractor shall submit painting specifications and procedures for SDG&E approval.

* 1. **Shipping Requirements**
     1. Intentionally Deleted. The Contractor shall prepare materials and equipment 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, SDG&E’s contract number, Contractors identifying number, and complete SDG&E shipping address. The Contractor shall pay particular attention to the proper packaging and bracing of the apparatus to assure its safe arrival.
     2. Systems, equipment, materials and components shall be transportable at normal speeds over North American highways and railways, and meet all USDOT hazardous materials and other requirements. System components may be shipped separately as needed and assembled on-site.
     3. 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. **Installation** 
     + 1. **Civil/Structural**

The Project shelter and required foundations and structures shall be designed by or under the supervision of a qualified California registered professional engineer or California registered architect as applicable. All design shall be in accordance with seismic design requirements as specified elsewhere in 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 SDG&E and local agencies. The Contractor shall be responsible for damage to public roadways resulting from the work performed.

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 SDG&E or other property for all repairs in the event of removal or damage of any existing structure, equipment or systems that are intended to remain in place.

* + - 1. **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 Cal-OSHA regulations. Excavation spoils shall be the Contractor’s responsibility, and may be used for backfill or embankment if suitable for this application. Unsuitable or excess excavated material shall be properly disposed of.

The Contractor shall verify that earth material exposed in excavations is consistent with those assumed for the Contractor’s foundation designs. If earth materials are different than assumed for particular foundation design the Contractor shall at SDG&E’s expense modify the design and/or treat the earth material (over excavate, replace, etc.) as necessary to provide foundation meeting design requirements.

* + - 1. **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 the plans and specifications.

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 California.

* + - 1. **Fills**

Earth fill material adjacent to and below structures shall conform to the Contractor’s design requirements for the structure. 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.

* + - 1. **Fencing**

Fencing is required for Contractor installed facilities. Such fence shall be a chain link mesh design, with a minimum height of 8 feet plus two feet of barbed wire. Such fence shall include lockable man gate for access.

* + - 1. **Jersey Barriers**

Jersey Barriers are required to protect contractor facilities/ESS installed within 20’ of public thoroughfares.

* + 1. **Control Shelter**

The Contractor shall design, engineer, and provide a shelter suitable for use to house the Project controls and all indoor components common to the Site. The Contractor shall provide on-Site inspection, and design review of the shelter required to accommodate the Project controls commensurate with the Project design life, including but not limited to seismic events, wind loads or other controlling criteria.

The Project shelter and containers shall be designed with the appropriate insulation to meet local building codes and ensure and energy efficient operation of the HVAC and/or ventilation system.

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

* + 1. **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 a complete and operable facility. The Contractor shall provide foundations for all Contractor supplied equipment and structures, as appropriate, including but not limited to shelters, containers, transformers, switches, breakers and instrument transformers.

ACI 318 and CBC 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 facility.

The appropriate manufacturer shall specify the quantity, size, and location of anchor bolts for enclosures and equipment. 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, concrete mix designs, and concrete 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 at no additional cost to SDG&E.

The Contractor shall ensure that no more than 5000 square feet of existing impervious surface is removed during construction of the Project within the Site (excluding the interconnection trench and conduit and/or horizontal directional drilling, cable and connection work from substation up to the Point(s) of Common Coupling).

* + 1. **Mechanical**

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

Outdoor enclosures shall be weatherproof and capable of surviving, intact, under the Site environmental conditions specified.

Components mounted inside of enclosures 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 each container and control shelter. The system shall be designed to maintain component temperatures at levels acceptable to the Contractor’s normal operating and warranty conditions for all modes of planned Project operation.

* + 1. **Communications and Control Technology**

Communications and control technology shall make use of industry standard components and be compatible with SDG&E’s existing environment for substation communications infrastructure.

* 1. **Reserved**
  2. **Required Training Courses**

The training courses described below, with accompanying written text, shall be a live presentation at an SDG&E facility with SDG&E 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 energy storage system, a pictorial breakdown of the energy storage subassemblies, procedures related to emergency response (ruptured modules, fire, etc.), and operation and control of the energy storage system.

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 1/2 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 Project performance verification tests. An outline for this orientation training shall be submitted to SDG&E 90 days ahead of the actual date of training. Approval of this outline shall be obtained from SDG&E. SDG&E will provide comments and/or approval 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 completion of the Project performance verification testing, but before system commissioning. It is anticipated that this session will last 1-2 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.

1. **FUNCTIONAL REQUIREMENTS**
   1. **General**

The Project will be capable of serving multiple purposes, each represented by a control mode. These modes will all be supported within the system capabilities and self-protection requirements. The system shall be able to move freely between each mode of operation at any time. In particular, it is intended that the Project will be operated as a Resource Adequacy resource.

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 battery partially discharged.

The system shall be capable of functioning in the modes currently available within the Contractor’s Advancion software.

For all modes, except modes that respond to abnormal system conditions, the Project shall ramp to the required output at an SDG&E selectable rate. Following a rated discharge or termination of the mode command, the Project shall ramp to zero at an SDG&E 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.

* 1. **Control Modes**
     1. **Offline**

The system 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
  + 1. **Standby**

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

* + 1. **Target SOC**

The system should charge according to its own optimum method considering an available time budget to reach a defined SOC value. If the system SOC falls below the reference SOC, 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 SDG&E 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 SDG&E’s system varies with time throughout the charging cycle. The Project control system shall allow SDG&E’s dispatcher to remotely initiate the Contractor-specified/programmed charge cycle. The maximum demand required by the charging cycle shall be SDG&E selectable, but shall not exceed the Contractor specified charge rate. The Contractor shall provide, with the proposal, 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.

* + 1. **Base load**

The system shall be able to charge or discharge at a fixed kW power level and provide capacitive or inductive VAr’s at a fixed kVAr reactive power level. The Contractor should provide the real/reactive power curve for the proposed system.

* + 1. **CAISO Frequency Regulation**

The Project may, at some future date, ultimately participate in the CAISO markets. Accordingly, the Project shall be capable of operation in compliance with CAISO regulation up and regulation down requirements.

* + 1. **CAISO Spinning Reserves**

The Project may, at some future date, ultimately participate in the CAISO markets. Accordingly, the Project shall be capable of discharging in accordance with the CAISO Spinning Reserves market requirements.

* + 1. **CAISO Non-Spinning Reserves**

The Project may, at some future date, ultimately participate in the CAISO markets. Accordingly, the Project shall be capable of discharging in accordance with the CAISO Non-Spinning Reserves market requirements.

* + 1. **Scheduling**

The system shall be able to schedule all modes mentioned above. Start and stop times shall be defined for each schedule operation. System should be able to accept recurring schedules (weekly, daily, and monthly).

* + 1. **Reserved.**
    2. **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 AGC. The Project voltage and frequency controls shall regulate the output based on appropriate SDG&E 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 at an SDG&E selectable rate.

* 1. **Permissive Operation States**
     1. A system of operational states shall permit the use of each mode of operation of the Project. Permissions will be granted by SDG&E via an SDG&E -specified process. The operational states are standby and parallel. The descriptions are as follows:
     2. **Standby**

Standby permission shall authorize the Project to be synchronized with the utility grid with no input or output from the inverter except auxiliary loads and all systems operational.

* + 1. **Parallel**

Parallel permission shall authorize the Project to operate in parallel with the utility grid, in any grid-connected mode of operation. When the Project is operating in this state and grid voltage is lost, the Project will conform to IEEE 1547, automatically disconnect from the utility grid and break parallel. Only after grid voltage is restored for the specified delay time, shall the system reconnect and operate in the parallel state.

* + 1. **Reserved**

1. **TECHNICAL REQUIREMENTS**
   1. **General**
      1. The Project shall include the lithium ion batteries, power conversion systems (inverter), all associated control and communication interface systems, all switchgear and any auxiliary loads necessary to support its operation to the point of common coupling with the utility.
      2. All loads necessary to operate and protect the system, such as controls, cooling systems, fans, pumps, and heaters, are considered auxiliary loads internal to the system.
      3. The “Point(s) of Common Coupling” shall be defined as terminal pads in the Contractor provided MV switchgear for termination of the SDG&Es conductors.
      4. Reserved.
      5. Systems shall be rated in terms of net delivered power and energy to the Point(s) of Common Coupling. 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 system and ratings are net of these loads and losses as measured (or calculated if not measured) to the Point(s) of Common Coupling.
      6. 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)
      7. The system shall be capable of charging and discharging real power, and dispatching both leading and lagging reactive power
      8. The system shall be capable of charging from 0% to 100% useable SOC and discharging from 100% to 0% useable SOC (its rated energy) for a minimum of duration as stated in the Product Specifications.
   2. **Ratings**
      1. 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.
      2. **AC Voltage**

Interconnection voltage is 12.00kV ±5%.

* + 1. **Auxiliary Voltage**

Auxiliary voltage is 480V

* + 1. **Power and Energy**

System ratings are defined in kVAAC or MVAAC and kWhAC or MWhAC.

* + 1. **Reserved**
    2. **Parasitic Losses**

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

* + 1. **Self-Discharge**

Contractor shall provide self-discharge characteristics.

* + 1. **Basic Insulation Level**

The Project AC system equipment shall have a Basic Insulation Level of 105 kV and otherwise comply with UL 1741 or ANSI C62.41.2-2002 standards.

* + 1. **Overload Capability**

It may be advantageous to SDG&E 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 proposed Project as a function of time. It is not a requirement of the specification to design specific overload capability into the Project.

* + 1. **Audible Noise:**

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

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.

* + - 1. Compliance Measurements:The Contractor shall make audible noise measurements before and after commissioning of the Project for the purpose of verifying compliance with the requirements. The measurements shall be made at three or more selected locations outside containers using a Type 1 sound level meter that complies with the requirements of ANSI S 1.4-1983 “American National Standard Specification for Sound Level Meters.”
    1. **Broadband Interface:**

The Contractor shall take necessary precautionary measures to insure that there will be no mis-operation, damage or danger to any equipment or system 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. 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 forthe 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.

* + 1. **Interference and Harmonic Suppression**

The PCS shall not produce Electromagnetic Interference (EMI) that will cause mis-operation of instrumentation, communication, or similar electronic equipment within the Project or on SDG&E’s 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. The Point of Common Coupling (PCC) shall be the 12kV interconnection point with the SDG&E system. 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.

* 1. **External AC Power Interface(s)**
     1. **Termination**
        1. All terminations and locations of terminations shall be pre-approved by SDG&E and specified in the appropriate submitted drawings.
        2. The Project shall include provision for standard four-hole pads on the Contractor supplied medium voltage switchgear for SDG&E’s conductor termination.

* + 1. **Isolation/Disconnect**

* + - 1. The Project shall be equipped with a means to isolate the power conditioning system from the step-up transformer. This may be accomplished through a lockable breaker.
      2. A MV interconnection isolation disconnect switch shall be provided 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 SDG&E will have full access and control over this device.
    1. **Use for Auxiliary power**

* + - 1. The auxiliary power system shall include, but are not limited to, breakers, fuses, relaying, panels, enclosures, junction boxes, conduits, raceways, wiring and similar equipment, as required for the Project operation.

Reserved.

* + 1. **Metering and Telemetry**

Contractor shall provide its own CT’s for protection and internal metering,.

SDG&E shall provide, install and wire the metering CT’s/PT’s, non CAISO telemetry equipment (if applicable), and test switches in preparation for the installation of SDG&E meters.

* 1. **System Protection Requirements**
     1. Contractor shall adhere to rules and regulations described on SDG&E’s Process For SDG&E Electric Distribution System Interconnection Handbook (Revised as of 10/21/2015).
     2. 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 prudent industry practices shall be a part of the AC system. The protective relaying and metering shall be integrated with the Project control system and communications channel to SDG&E’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 protection of the utility substation where the Project is connected.

The Contractor shall use microprocessor type protection equipment to the extent possible

The low side bus and cable shall be protected by overcurrent relays.

* 1. **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 SDG&E.

Wires shall have identifying labels or markings on both ends. The labels shall identify the opposite end destination.

Control and instrumentation wiring shall be separated from power and high voltage wiring by use of separate compartments or enclosures or by use of separate wireways and appropriate barrier strips within a common enclosure as required by the NEC.

Project and PCS control and instrumentation system wiring shall be bundled, laced and otherwise laid in an orderly manner. Wires shall be of sufficient length to preclude mechanical stress on terminals. Wiring around hinged panels or doors shall be extra flexible (Class K stranding or equivalent) and shall include loops to prevent mechanical stress or fatigue on the wires.

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.

* 1. **Modular Replacement**

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

* 1. **Physical Characteristics**
     1. Systems shall meet all Occupational Safety and Health Administration (OSHA), National Electric Code (NEC), IEEE, ANSI, CBC and National Fire Protection Association (NFPA) requirements for electrical and fire safety.
     2. Systems shall be designed to minimize footprint and volume. Systems 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.
     3. The Project components shall be contained within weatherproof, tamper resistant, metal enclosures suitable for mounting outdoors on a concrete, fiberglass or equivalent pad with a minimum NEMA 3R rating if installed in a standalone outdoor application, or within a shelter that meets all seismic, safety, and fire resistance requirements stated in this specification.
     4. Any enclosures shall be dust tight to at least the NEMA 3R rating, except as designed to allow forced air exchange with the atmosphere.
     5. Project Modules PCS, and controls shall be accessible and removable for replacement.
     6. 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 shelter or each enclosure.
     7. All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the shelter or each enclosure.
  2. **Cycle life**
     1. If the proposed lithium ion batteries are sensitive to depth of discharge, the manufacturer must state the limitations and the product should be sized such that the depth of discharge corresponds to the required cycle life.
     2. For purposes of estimating and demonstrating cycle life, cycles are defined in terms of energy charged and discharged from the Project. Additional details are included in the Contractor’s warranty terms and conditions.
     3. The Contractor shall provide a graph or set of graphs that displays the relationship between depth of discharge and the corresponding number of cycles available within the system’s life.
  3. **Management System** 
     1. As a subcomponent of a Project, a Management System (MS) shall be included to manage the operational health of the Project and assure its safe and optimal performance of the Project as an interconnected asset to SDG&E’s electrical system. Primary functions include but are not limited to:
     2. Monitoring:
        1. State of Charge
        2. State of Health
        3. Voltage/Current
        4. Temperature
        5. Status
     3. Charge/discharge management
     4. Balancing
     5. Warning and alarms
     6. Internal protective measures
     7. Logs of operations
     8. Management of any software versions
     9. Cyber Security management of the device itself
     10. Provide data exchange to the Site Energy Controller
     11. Contribute to functional safety of overall Project
  4. **Power Conversion System**

The PCS shall be capable of operating in all four power quadrants at rated power (kVA/MVA). Any combination of kW/MW and kVAR/MVAR output shall be possible that is consistent with the systems rated power.

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).

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 taken into account.

The PCS system shall include provisions for disconnection on both the AC and DC terminal, for maintenance work. Conductor separation must be clearly visible; flags or indicators are not acceptable. These disconnects shall be capable of being locked open for maintenance work. Any PCS capacitors shall be provided with bleeder resistors or other such means of discharging capacitors to less than 50 volts within one five (5) minutes of de-energization per UL1741 requirements. .

* 1. **Site Energy Controller (SEC)**
     1. 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.
     2. The Project shall include the necessary communication and telemetry hardware, and support communications protocols, to effectively provide the required services.
     3. No single mode of failure shall result in loss of power to the control and data acquisition module.
     4. The control shall include provisions for an orderly and safe shutdown in the absence of utility power.
     5. **Operations and Control Functions**
        1. 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:
           1. Protect itself (isolate for any internal fault)
           2. Remain within power constraints (transformer and Project ratings)
           3. Remain within voltage constraints
           4. Remain within operating temperature constraints
           5. Isolate in response to system anomalies
           6. Charge/discharge Real Power and Reactive Power in response to SEC programs or external commands
           7. Communicate status and diagnostic data
        2. The SEC Shall respond to commands issued remotely or locally, including but not limited to:
           1. Change Modes (charge, discharge, etc.)
           2. Change Status (enable/disable)
           3. Reset Alarms
           4. System Reset/Restart

* + 1. **Permissive Operational States**
       1. As stated in the functional requirements, SDG&E will permit the use of the Project in specific operational states remote signals.
       2. The Project must be able to integrate with the dispatch center to allow for and acknowledge each operational state.
       3. A command table must be submitted by the Contractor and approved by SDG&E engineering prior to the acceptance of the controller and factory acceptance test.
    2. **Local Human Machine Interface**
       1. 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.
       2. Local password protection is required. Different login accounts shall be set up to allow for different types of operators (i.e. observer: read, operator: read/write).
       3. Meaningful control buttons and indicating lights shall be provided for monitor and control status and operations.
       4. All control and alarm functions available remotely shall also be available locally.
    3. **Remote Operations**
       1. 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.
       2. 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.
       3. 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 5 minutes). When communications have been re-established, the PROJECT and remote controller shall make any necessary updates to resume performance.
       4. SDG&E shall provide Internet connection as follows:
          1. Bandwidth: symmetric 10 Mbps for Internet (10 Mb/s US and 10 Mb/s DS)
          2. Availability: 99.999999%
          3. Stability: jitter should be less than 5% of the delay.
          4. Local loop: fiber
          5. Deliverable in: 2 ETH interfaces with 2 public IP addresses

* + 1. **Monitoring, Data Logging, Alarms, and Status**

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

* + - 1. Operation Control
      2. Operation Status
      3. System Information
      4. AC/DC Status
      5. Counters
      6. Status
      7. Device Status and Error Codes (Alarms)
      8. Log of Operations
      9. Historical data and trending
  1. **Communications**
     1. The Project and all its subcomponents required for operation shall be configured to be on its own sub-network, separate from any SDG&E communications network.
     2. A single point of connection, via a hardened router, shall be used to interface with any external SDG&E’s networks either through Ethernet or Fiber connections.
     3. A modern IP-based protocol shall be used for external communications with SDG&E’s networks.
     4. The Project may, at some future date, ultimately participate in the CAISO markets. The ESS shall be capable of integration with CAISO control systems and telemetry systems.
  2. **Information Security**
     1. Contractor shall design the Project to be hardened against willful attack or human negligence as per NISTIR 7628.
     2. Contractor shall contract information/cyber security scans and penetration tests by an SDG&E approved 3rd party security company, prior to SDG&E acceptance. SDG&E reserves the right to perform its own internal security testing in addition to the Contractor’s testing.
     3. 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.
  3. **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, etc.). The heat removal and/or cooling system will include mechanical vapor cooling. Final rejection of all waste heat from the system shall be to the ambient air. Air handling systems shall include filters to prevent dust intrusion into the system.

* 1. **Fire Mitigation**
     1. The Contractor shall design its system to minimize any potential risks of fires.
     2. Where containers or shelters are used, provisions shall be included to extinguish internal container or shelter fires without the need to open container or shelter doors.
  2. **Station DC system and** **Uninterruptible Power Supply**

The Project shall be equipped with a Station DC system and/or an UPS to power essential functions in the event of a total failure of auxiliary supply systems(s) if required for orderly shutdown. The provided DC system/UPS shall comply with the applicable standards.

* 1. **Battery System Design**

The Contractor shall design, furnish and install a lithium ion battery system that meets all of the requirements of this specification.

* + 1. **Cells**

The battery shall consist of lithium ion 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 can be supplied on short notice throughout the Project life will be allowed.

The cells may be supplied as separate, individual units or as group of cells combined into modules.

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 battery.

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.

The battery subsystem as a whole and as individual cells shall be designed to withstand seismic events as described herein.

The battery may consist of one or more parallel strings of cells.

DC wiring shall be sized for maximum battery current and be braced for available fault currents. Protection shall include a DC breaker, fuse or other current-limiting device on the battery bus. This protection shall be coordinated with the PCS capabilities and battery string protection, and shall take into account transients and the L/R ratio at the relevant areas of the DC system.

The battery system may operate at any DC voltage.

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 the maximum expected voltages plus a suitable factor of safety.

The Contractor shall have overall responsibility for the safety of the electrical design and installation of the battery.

The battery system 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.

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 all types of cell failures that are commonly known to occur for the type of cell used.

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 system shall be integrated into the overall control system.

The battery system shall include racks or shall consist of stackable modules. 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.

All racks and metallic conductive members of stackable modules shall be solidly grounded. Racks shall be seismically qualified in accordance with IEEE 693 High Seismic Qualification Level and shall include means to restrain cell movement during seismic events.

1. **Acronyms & Definitions**

**MS –**Management System

**CT** – Current Transformer

**FAT** – Factory Acceptance Test

**HMI** – Human Machine Interface

**MSDS** – Material Safety Data Sheet

**OSHA –** Occupational Safety and Health Administration (refers to both OSHA and Cal-OSHA)

**PCC –** Point of Common Coupling

**PCS –** Power Conversion System

**PT** – Potential Transformer

**SCADA** – Supervisory Control and Data Acquisition

**SDG&E** – San Diego Gas & Electric

**SEC** – Site Energy Controller

**SOC** – State of Charge or Energy: Nominal Energy Remaining / Nominal Full Pack Energy Available

**UPS** – Uninterruptible Power Supply

1. **Applicable Standards and Codes**

|  |  |  |
| --- | --- | --- |
| **1** | **ANSI/IEEE C2** | National Electric Safety Code |
| **2** | **Reserved** |  |
| **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 600V A.C. |
|  | **UL 1973** | Standards for Batteries for Use in Light Electric Rail Applications and Stationary Applications |
| **14** | **Electric Tariff Rule 21** | Generating Facility Interconnections |
| **15** | **NISTIR 7628** | Guidelines for Smart Grid Cyber Security |
| **16** | **NEC** | National Electric Code |
| **17** | **NESC** | National Electric Safety Code |
| **18** | **GO95, GO128** | CPUC’s General Order 95 and 128 |
| **19** | **CBC** | California Building Code |
| **20** |  | Clean Air Act and Amendments |
|  | **CFC** | California Fire Code |
| **21** |  | Comprehensive Environmental Response, Compensation, and Liability Act of1980 |
| **22** | **EPA** | Environmental Protection Agency regulations |
| **23** | **FAA** | Federal Aviation Administration regulations |
| **24** | **FERC** | Federal Energy Regulatory Commission regulations |
| **25** |  | Federal Power Act |
| **26** |  | Noise Control Act of 1972 |
| **27** | **OSHA** | Occupational Safety and Health Act |
| **28** | **RCRA** | Resource Conservation and Recovery Act |
| **29** | **SDWA** | Safe Drinking Water Act |
| **30** | **SWDA** | Solid Waste Disposal Act |
| **31** | **TSCA** | Toxic Substances Control Act |
| **32** | **ADA** | Americans with Disabilities Act |
| **33** | **MBTA** | Migratory Bird Treaty Act |
| **34** | **CWA** | Clean Water Act |
| **35** | **ANSI** | American National Standards Institute |
| **36** | **IEEE** | Institute of Electrical and Electronics Engineers |
| **37** | **CPUC** | California Public Utilities Commission |
| **38** | **NEMA** | National Electrical Manufacturers Association |
| **39** | **ASTM** | American Society for Testing and Materials |
| **40** | **ASME** | American Society of Mechanical Engineers |

1. **DNP3 Points List**

**Overview**

The following is information of the data objects being used by SDG&E for the purposed of controlling and monitoring storage systems via a communications gateway. The current SDG&E standard for this gateway is an SMP16 or SMP4. The appropriately deployed gateway implements a DNP3/TCP protocol, and provides a standardized points list that both applications and storage systems shall integrate with.

To follow the standardized points list, the integration of storage systems may require some modifications and logic functions to be placed within the gateway itself. SDG&E strongly desires that systems comply with this standard with a minimum of modification and related custom engineering/configuration.

Note that the alarms list for each system has not been listed, as systems provide a multitude of alarms. Instead, this standard list showcases rolled up alarms. In all cases, the mappings of alarms must be added as binary inputs and rolled up into the main alarms. It should be also noted that this points list is updated over time and future points may be required.

**Data Object List**

Each input and output is broken down into categories and subcategories. To differentiate each Advanced Energy Storage system, the following nomenclature will be followed to configure each point name in the SMP16 (or SMP4):

**[*SES or CES][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 SDG&E as part of system deployment planning and provisioning.

|  |  |
| --- | --- |
| Category | Abbreviation |
| System | SYS |
| Inverter | INV |
| Battery | BATT |

\*none for control

*Example*:

*SES1\_SYS\_CHRG\_KW\_LIMIT*

*SES2\_INV1\_AC\_BRKR\_STATUS*

When being defined at the PI AF level, the following nomenclature will be followed:

**AES:[*Substation abbv.*]\_[*SMP Point Name]***

Example Substation abbreviations are as follows:

|  |  |
| --- | --- |
| Substation | Abbreviation |
| SUBSTATION X | SUBX |
| SUBSTATION Y | SUBY |
| SUBSTATION Z | SUBZ |

Example:

*AES:SUBX\_SYS\_CHRG\_KW\_LIMIT*

*AES:SUBZ\_SES2\_INV1\_AC\_BRKR\_STATUS*

* 1. Analog Inputs

|  |  |  |  |
| --- | --- | --- | --- |
| **Operational Mode** | **Name** | **Point Name** | **Units** |
| System Information Points → PREFIX = "SYS\_" | | | |
| - | Present Real Power Mode of Operation | P\_MODE | - |
| 0: Offline (AC Breakers Open) |
| 1: Standby (AC Breaker Closed, Waiting for Next Mode to be Selected) |
| 2: Base Mode |
| 3: Frequency Regulation |
| 4: Real Power Load Shifting |
| 5: Load Smoothing |
| 6: Target SOC |
| 7: VSI VF (indicates Voltage and Freq. set by asset, no other operational modes possible at this time) |
| - | Present Reactive Power Mode of Operation | Q\_MODE | - |
| 0: Offline (AC Breakers Open) |
| 1: Standby (AC Breaker Closed, Waiting for Next Mode to be Selected) |
| 2: Base Mode |
| 3: Voltage Regulation |
| 4: Reactive Power Load Shifting |
| 5: VSI VF (indicates Voltage and Freq. set by asset, no other operational modes possible at this time) |
| - | Present System State | STATE | - |
| 0: Offline (All INV faulted/inhibited and all AC breakers open) |
| 1: Ready (At least 1 INV clear of faults/inhibits and AC Breakers open) |
| 2: Running (AC Breakers closed on at least 1 INV) |
| 3: Island (VSI VF Activated) |
| - | Voltage Source Mode Enabled (0 = CSI, 1= VSI) for System | VSI\_MODE | - |
| - | Charge Real Power Limit | CHRG\_KW\_LIMIT | KW |
| - | Discharge Real Power Limit | DCHRG\_KW\_LIMIT | kW |
| - | Inductive (Sink) Reactive Power Limit | SINK\_KVAR\_LIMIT | kVAR |
| - | Capacitive (Source) Reactive Power Limit | SOURCE\_KVAR\_LIMIT | kVAR |
| - | Minimum Cell Voltage | MIN\_CELL\_VOLT | V |
| - | Maximum Cell Voltage | MAX\_CELL\_VOLT | V |
| - | Minimum Cell Temperature | MIN\_CELL\_TEMP | °C |
| - | Maximum Cell Temperature | MAX\_CELL\_TEMP | °C |
| - | Real Power Ramp Rate | KW\_RAMP\_RATE | KW/Min |
| - | Reactive Power Ramp Rate | KVAR\_RAMP\_RATE | KVAR/Min |
| System Metered Value Points → PREFIX = "SYS\_" | | | |
| - | Average State of Charge | SOC | % |
| - | Capacity | CAP\_KWH | KWH |
| - | State of Health | SOH | % |
| - | Real Power | KW | KW |
| - | Reactive Power | KVAR | KVAR |
| - | Power Factor | PF | - |
| - | Average AC Phase Current | AC\_AMPS | A |
| - | A Phase Current | AC\_AMPS\_A | A |
| - | B Phase Current | AC\_AMPS\_B | A |
| - | C Phase Current | AC\_AMPS\_C | A |
| - | Average Line to Line AC Voltage | AC\_VOLT | V |
| - | AB Line to Line AC Voltage | AC\_VOLT\_AB | V |
| - | BC Line to Line AC Voltage | AC\_VOLT\_BC | V |
| - | CA Line to Line AC Voltage | AC\_VOLT\_CA | V |
| - | Frequency | HZ | HZ |
| System Counter Points → PREFIX = "SYS\_" | | | |
| - | Energy Charged | CHRG\_KWH | KWH |
| - | Energy Discharged | DCHRG\_KWH | KWH |
| Local/Remote PCC Information and Meter Points → PREFIX = "SWITCH\_ID\_ " (Requires collaboration between SDG&E and Vendor to get these points mapped into Asset Protocol Instance) | | | |
| - | Local Dist. Switch Average AC Phase Current (per switch position) | AMPS | A |
| - | Local Dist. Switch Real Power (per switch position) | MW | MW |
| - | Local Dist. Switch Reactive Power (per switch position) | MVAR | MVAR |
| - | Local Dist. Switch Switch Position (0 = Open, 1 = Closed; per switch position) | POSITION | - |
| - | Remote Switch Average AC Phase Current (per remote switch) | AMPS | A |
| - | Remote Switch Real Power (per remote switch position) | MW | MW |
| - | Remote Switch Reactive Power (per remote switch position) | MVAR | MVAR |
| - | Remote Switch Switch Position (0 = Open, 1 = Closed; per remote switch position) | POSITION | - |
| Inverter Information Points → PREFIX = "INV\_" | | | |
| - | Present Inverter State | STATE | - |
| 0: Offline (INV faulted/inhibited and AC breaker open) |
| 1: Ready (INV clear of faults/inhibits and AC Breaker open) |
| 2: Running (AC Breaker closed) |
| - | Voltage Source Mode Enabled (0 = CSI, 1= VSI) for Inverter | VSI\_MODE | - |
| - | Charge Power Limit | CHRG\_KW\_LIMIT | KW |
| - | Discharge Power Limit | DCHRG\_KW\_LIMIT | kW |
| - | Inductive (Sink) Reactive Power Limit | SINK\_KVAR\_LIMIT | kVAR |
| - | Capacitive (Source) Reactive Power Limit | SOURCE\_KVAR\_LIMIT | kVAR |
| - | Real Power Ramp Rate | KW\_RAMP\_RATE | KW/Min |
| - | Reactive Power Ramp Rate | KVAR\_RAMP\_RATE | KVAR/Min |
| Inverter Metered Value Points → PREFIX = "INV\_" | | | |
| - | Real Power | KW | KW |
| - | Reactive Power | KVAR | KVAR |
| - | Power Factor | PF | - |
| - | Average AC Phase Current | AC\_AMPS | A |
| - | Average Line to Line AC Voltage | AC\_VOLT | V |
| - | A Phase AC Current | AC\_AMPS\_A | A |
| - | B Phase AC Current | AC\_AMPS\_B | A |
| - | C Phase AC Current | AC\_AMPS\_C | A |
| - | AB Line to Line AC Voltage | AC\_VOLT\_A | V |
| - | BC Line to Line AC Voltage | AC\_VOLT\_B | V |
| - | CA Line to Line AC Voltage | AC\_VOLT\_C | V |
| - | DC Current | DC\_AMPS | A |
| - | DC Voltage | DC\_VOLT | V |
| - | Frequency | HZ | HZ |
| Inverter Counter Points → PREFIX = "INV\_" | | | |
| - | Energy Charged | CHRG\_KWH | KWH |
| - | Energy Discharged | DCHRG\_KWH | KWH |
| Battery Information Points → PREFIX = "BATT\_" | | | |
| - | Number of Strings Connected | NUM\_STR\_CONN | - |
| - | DC Container Voltage | DC\_VOLT | V |
| - | DC Container Current | DC\_AMPS | A |
| - | Minimum Cell Voltage | MIN\_CELL\_VOLT | V |
| - | Average Cell Voltage | AVG\_CELL\_VOLT | V |
| - | Maximum Cell Voltage | MAX\_CELL\_VOLT | V |
| - | Minimum Cell Temperature | MIN\_CELL\_TEMP | °C |
| - | Maximum Cell Temperature | MAX\_CELL\_TEMP | °C |
| Battery Metered Value Points → PREFIX = "BATT\_" | | | |
| - | State of Charge | SOC | % |
| - | Capacity | CAP\_KWH | KWH |
| - | State of Health | SOH | % |
| System AO Feedback (FB) Points → PREFIX = "SESx\_" | | | |
| General | Heartbeat from Gateway Being Sent to Asset | HEART\_BEAT\_FB | - |
| General | Real Power Mode of Operation Being Sent to Asset | P\_MODE\_FB | - |
| 0: Offline (AC Breaker Open) |
| 1: Standby (AC Breaker Closed, No Other Mode Selected) |
| 2: Base Mode |
| 3: Frequency Regulation |
| 4: Real Power Load Shifting |
| 5: Real Power Load Smoothing |
| 6: Target SOC |
|  | 7: VSI VF |
| General | Reactive Power Mode of Operation Being Sent to Asset | Q\_MODE\_FB | - |
| 0: Offline (AC Breaker Open) |
| 1. Standby (AC Breaker Closed, No Other Mode Selected) |
| 2: Base Mode |
| 3: Voltage Regulation |
| 4: Reactive Power Load Shifting |
|  | 5: Reactive Power Load Smoothing |
|  | 6: VSI VF |
| CSI/VSI | Voltage Source Mode Selection (0 = CSI, 1= VSI) Being Sent to Asset | VSI\_MODE\_FB | - |
| Base P Mode | Real Power Setpoint Being Sent to Asset | BASE\_KW\_FB | KW |
| Frequency Regulation | Frequency Regulation Frequency Setpoint Being Sent to Asset | FREQ\_REG\_HZ\_FB | Hz |
| Frequency Regulation | Frequency Regulation Frequency Deadband (+/-) Being Sent to Asset | FREQ\_REG\_DB\_HZ\_FB | Hz |
| Frequency Regulation | Frequency Regulation SOC Upper Limit (UL) Being Sent to Asset | FREQ\_REG\_SOC\_UL\_FB | % |
| Frequency Regulation | Frequency Regulation SOC Lower Limit (LL) Being Sent to Asset | FREQ\_REG\_SOC\_LL\_FB | % |
| Frequency Regulation | Frequency Regulation Reference Signal at PCC Being Sent to Asset | FREQ\_REG\_REF\_SIG\_FB | Hz |
| Real Power Load Shifting | Load Shifting Real Power Upper Limit (UL) Being Sent to Asset | LD\_SHFT\_UL\_KW\_FB | KW |
| Real Power Load Shifting | Load Shifting Real Power Lower Limit (LL) Being Sent to Asset | LD\_SHFT\_LL\_KW\_FB | KW |
| Real Power Load Shifting | Load Shifting SOC Upper Limit (UL) Being Sent to Asset | LD\_SHFT\_SOC\_UL\_FB | % |
| Real Power Load Shifting | Load Shifting SOC Lower Limit (LL) Being Sent to Asset | LD\_SHFT\_SOC\_LL\_FB | % |
| Real Power Load Shifting | Load Shifting Reference Signal Being Sent to Asset | LD\_SHFT\_REF\_SIG\_FB | KW |
| Real Power Load Smoothing | Load Smoothing Real Power Ramp Rate (+/-) Limit Being Sent to Asset | LD\_SMTH\_RAMP\_RATE\_FB | KW/Min |
| Real Power Load Smoothing | Load Smoothing SOC Upper Limit (UL) Being Sent to Asset | LD\_SMTH\_SOC\_UL\_FB | % |
| Real Power Load Smoothing | Load Smoothing SOC Lower Limit (LL) Being Sent to Asset | LD\_SMTH\_SOC\_LL\_FB | % |
| Real Power Load Smoothing | Load Smoothing Real Power Reference Signal Being Sent to Asset | LD\_SMTH\_REF\_SIG\_FB | KW |
| Target SOC | Target SOC Setpoint Being Sent to Asset | TRGT\_SOC\_FB | % |
| Target SOC | Target SOC Deadband (+/-) Being Sent to Asset | TRGT\_SOC\_DB\_FB | % |
| Target SOC | Target SOC Real Power Limit Being Sent to Asset | TRGT\_SOC\_KW\_FB | KW |
| Base Q Mode | Reactive Power Setpoint Being Sent to Asset | BASE\_KVAR\_FB | KVAR |
| Voltage Regulation | Voltage Regulation Voltage Setpoint Being Sent to Asset | VOLT\_REG\_VOLT\_FB | V |
| Voltage Regulation | Voltage Regulation Voltage Deadband (+/-) Being Sent to Asset | VOLT\_REG\_DB\_FB | % |
| Voltage Regulation | Voltage Regulation Reference Signal at PCC Being Sent to Asset | VOLT\_REG\_REF\_SIG\_FB | V |
| Reactive Power Load Shifting | Reactive Power Load Shifting Upper Limit (UL) Being Sent to Asset | RLD\_SHFT\_UL\_KVAR\_FB | KVAR |
| Reactive Power Load Shifting | Reactive Power Load Shifting Lower Limit (LL) Being Sent to Asset | RLD\_SHFT\_LL\_KVAR\_FB | KVAR |
| Reactive Power Load Shifting | Reactive Power Load Shifting Reference Signal Being Sent to Asset | RLD\_SHFT\_REF\_SIG\_FB | KVAR |
| Reactive Power Load Smoothing | Load Smoothing Reactive Power Ramp Rate (+/-) Limit Being Sent to Asset | RLD\_SMTH\_RAMP\_RATE\_FB | KVAR/Min |
| Reactive Power Load Smoothing | Load Smoothing Reactive Power Reference Signal Being Sent to Asset | RLD\_SMTH\_REF\_SIG\_FB | KVAR |
| VF Controller/Island Mode | Voltage Source (VSI VF) Voltage Setpoint Being Sent to Asset | VOLT\_VSI\_VF\_FB | V |
| VF Controller/Island Mode | Voltage Source (VSI VF) Frequency Setpoint Being Sent to Asset | HZ\_VSI\_VF\_FB | Hz |

Binary Inputs

|  |  |
| --- | --- |
| **Name** | **Point Name** |
| Protocol Communication Point | |
| Protocol Communication Failure | \_\_\_CommFail |
| System Information Points | |
| Local/Remote Control | LOCAL\_REMOTE\_STATUS |
| Island Enabled | ISLAND\_ENBLD\_STATUS |
| AC Breaker Status | AC\_BRKR\_STATUS |
| DC Contactor Status | DC\_CNTR\_STATUS |
| System Alarm Points | |
| Warning | WARNING\_ALARM |
| Fault | FAULT\_ALARM |
| Fire | FIRE\_ALARM |
| E-Stop Active | ESTOP\_ALARM |
| Inverter Information Points | |
| Local/Remote Control | LOCAL\_REMOTE\_STATUS |
| AC Breaker Status | AC\_BRKR\_STATUS |
| DC Contactor Status | DC\_CNTR\_STATUS |
| Inverter Alarm Points | |
| Warning | WARNING\_ALARM |
| Fault | FAULT\_ALARM |
| Fire | FIRE\_ALARM |
| E-Stop Active | ESTOP\_ALARM |
| Battery Alarm Points | |
| Warning | WARNING\_ALARM |
| Fault | FAULT\_ALARM |
| Fire | FIRE\_ALARM |
| E-Stop Active | ESTOP\_ALARM |

Analog Outputs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Operational Mode** | **Setpoint Description** | **Point Name** | **Units** | **Notes** |
| System AO Control Points | | | | |
| General | Heartbeat from Gateway Being Sent to Asset | HEART\_BEAT\_OUT | - |  |
| General | Real Power Mode of Operation Being Sent to Asset | P\_MODE\_OUT | - | - |
| 0: Offline (AC Breaker Open) |
| 1: Standby (AC Breaker Closed, No Other Mode Selected) |
| 2: Base Mode |
| 3: Frequency Regulation |
| 4: Real Power Load Shifting |
| 5: Real Power Load Smoothing |
| 6: Target SOC |
| 7: VSI VF (indicates Voltage and Freq. set by asset, no other operational modes possible at this time) |
| General | Reactive Power Mode of Operation Being Sent to Asset | Q\_MODE\_OUT | - | - |
| 0: Offline (AC Breaker Open) |
| 1. Standby (AC Breaker Closed, No Other Mode Selected) |
| 2: Base Mode |
| 3: Voltage Regulation |
| 4: Reactive Power Load Shifting |
| 5: Reactive Power Load Smoothing |
| 6: VSI VF (indicates Voltage and Freq. set by asset, no other operational modes possible at this time) |
| CSI/VSI | Voltage Source Mode Selection (0 = CSI, 1= VSI) Being Sent to Asset | VSI\_MODE\_OUT | - | - |
| Base P Mode | Real Power Setpoint Being Sent to Asset | BASE\_KW\_OUT | KW | - |
| Frequency Regulation | Frequency Regulation Frequency Setpoint Being Sent to Asset | FREQ\_REG\_HZ\_OUT | Hz | - |
| Frequency Regulation | Frequency Regulation Frequency Deadband (+/-) Being Sent to Asset | FREQ\_REG\_DB\_HZ\_OUT | Hz | - |
| Frequency Regulation | Frequency Regulation SOC Upper Limit (UL) Being Sent to Asset | FREQ\_REG\_SOC\_UL\_OUT | % | Stop operation above this |
| Frequency Regulation | Frequency Regulation SOC Lower Limit (LL) Being Sent to Asset | FREQ\_REG\_SOC\_LL\_OUT | % | Stop operation below this |
| Frequency Regulation | Frequency Regulation Reference Signal at PCC Being Sent to Asset | FREQ\_REG\_REF\_SIG\_OUT | Hz | - |
| Real Power Load Shifting | Load Shifting Real Power Upper Limit (UL) Being Sent to Asset | LD\_SHFT\_UL\_KW\_OUT | KW | Discharge above this limit |
| Real Power Load Shifting | Load Shifting Real Power Lower Limit (LL) Being Sent to Asset | LD\_SHFT\_LL\_KW\_OUT | KW | Charge below this limit |
| Real Power Load Shifting | Load Shifting SOC Upper Limit (UL) Being Sent to Asset | LD\_SHFT\_SOC\_UL\_OUT | % | Stop operation above this |
| Real Power Load Shifting | Load Shifting SOC Lower Limit (LL) Being Sent to Asset | LD\_SHFT\_SOC\_LL\_OUT | % | Stop operation below this |
| Real Power Load Shifting | Load Shifting Reference Signal Being Sent to Asset | LD\_SHFT\_REF\_SIG\_OUT | KW | - |
| Real Power Load Smoothing | Load Smoothing Real Power Ramp Rate (+/-) Limit Being Sent to Asset | LD\_SMTH\_RAMP\_RATE\_OUT | KW/Min | (Dis)charge outside this limit |
| Real Power Load Smoothing | Load Smoothing SOC Upper Limit (UL) Being Sent to Asset | LD\_SMTH\_SOC\_UL\_OUT | % | Stop operation above this |
| Real Power Load Smoothing | Load Smoothing SOC Lower Limit (LL) Being Sent to Asset | LD\_SMTH\_SOC\_LL\_OUT | % | Stop operation below this |
| Real Power Load Smoothing | Load Smoothing Real Power Reference Signal Being Sent to Asset | LD\_SMTH\_REF\_SIG\_OUT | KW | - |
| Target SOC | Target SOC Setpoint Being Sent to Asset | TRGT\_SOC\_OUT | % | - |
| Target SOC | Target SOC Deadband (+/-) Being Sent to Asset | TRGT\_SOC\_DB\_OUT | % | - |
| Target SOC | Target SOC Real Power Limit Being Sent to Asset | TRGT\_SOC\_KW\_OUT | KW | - |
| Base Q Mode | Reactive Power Setpoint Being Sent to Asset | BASE\_KVAR\_OUT | KVAR | - |
| Voltage Regulation | Voltage Regulation Voltage Setpoint Being Sent to Asset | VOLT\_REG\_VOLT\_OUT | V | - |
| Voltage Regulation | Voltage Regulation Voltage Deadband (+/-) Being Sent to Asset | VOLT\_REG\_DB\_OUT | % | - |
| Voltage Regulation | Voltage Regulation Reference Signal at PCC Being Sent to Asset | VOLT\_REG\_REF\_SIG\_OUT | V | - |
| Reactive Power Load Shifting | Reactive Power Load Shifting Upper Limit (UL) Being Sent to Asset | RLD\_SHFT\_UL\_KVAR\_OUT | KVAR | Source VARs above this limit |
| Reactive Power Load Shifting | Reactive Power Load Shifting Lower Limit (LL) Being Sent to Asset | RLD\_SHFT\_LL\_KVAR\_OUT | KVAR | Sink VARs below this limit |
| Reactive Power Load Shifting | Reactive Power Load Shifting Reference Signal Being Sent to Asset | RLD\_SHFT\_REF\_SIG\_OUT | KVAR | - |
| Reactive Power Load Smoothing | Load Smoothing Reactive Power Ramp Rate (+/-) Limit Being Sent to Asset | RLD\_SMTH\_RAMP\_RATE\_OUT | KVAR/Min | - |
| Reactive Power Load Smoothing | Load Smoothing Reactive Power Reference Signal Being Sent to Asset | RLD\_SMTH\_REF\_SIG\_OUT | KVAR | - |
| VF Controller/Island Mode | Voltage Source (VSI VF) Voltage Setpoint Being Sent to Asset | VOLT\_VSI\_VF\_OUT | V | - |
| VF Controller/Island Mode | Voltage Source (VSI VF) Frequency Setpoint Being Sent to Asset | HZ\_VSI\_VF\_OUT | Hz | - |

1. **Cybersecurity Requirements**

| **Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements[[1]](#footnote-2)** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Access Control (SG.AC)** | | | |
| SG.AC-1: Access Control Policy and Procedures | Requirement |  | **X** |
| SG.AC-2: Remote Access Policy and Procedures | Requirement | **X** | **X** |
| SG.AC-3: Account Management | Requirement | **X** |  |
| SG.AC-4: Access Enforcement | Requirement | **X** |  |
| SG.AC-5: Information Flow Enforcement | Requirement |  |  |
| SG.AC-6: Separation of Duties | Requirement | **X** |  |
| SG.AC-7: Least Privilege | Requirement | **X** |  |
| SG.AC-8: Unsuccessful Login Attempts | Requirement | **X** |  |
| SG.AC-9: Smart Grid Information System Use Notification | Requirement |  |  |
| SG.AC-10: Previous Logon Notification | Requirement |  |  |
| SG.AC-11: Concurrent Session Control | Requirement |  |  |
| SG.AC-12: Session Lock | Requirement |  |  |
| SG.AC-13: Remote Session Termination | Requirement | **X** |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| SG.AC-14: Permitted Actions Without Identification or Authentication | Requirement |  |  |
| Enhancement |  |  |
| SG.AC-15: Remote Access | Requirement | **X** | **X** |
| Enhancement |  |  |
| SG.AC-16: Wireless Access Restrictions | Requirement | **X** |  |
| SG.AC-17: Access Control for Portable and Mobile Devices | Requirement |  |  |
| Enhancement |  |  |
| SG.AC-18: Use of External Information Control Systems | Requirement | **X** |  |
| Enhancement |  |  |
| SG.AC-19: Control System Access Restrictions | Requirement |  |  |
| SG.AC-20: Publicly Accessible Content | Requirement |  |  |
| SG.AC-21: Passwords | Requirement | **X** |  |
| **Awareness and Training (SG.AT)** | | | |
| SG.AT-1: Awareness and Training Policy and Procedures | Requirement |  | **X** |
| SG.AT-2: Security Awareness | Requirement |  |  |
| SG.AT-3: Security Training | Requirement | **X** |  |
| SG.AT-4: Security Awareness and Training Records | Requirement |  |  |
| SG.AT-5: Contact with Security Groups and Associations | Requirement |  |  |
| SG.AT-6: Security Responsibility Training | Requirement | **X** |  |
| SG.AT-7: Planning Process Training | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Audit and Accountability (SG.AU)** | | | |
| SG.AU-1: Audit and Accountability Policy and Procedures | Requirement |  |  |
| SG.AU-2: Auditable Events | Requirement | **X** |  |
| Enhancement | **X** |  |
| SG.AU-3: Content of Audit Records | Requirement |  |  |
| SG.AU-4: Audit Storage Capacity | Requirement |  |  |
| SG.AU-5: Response to Audit Processing Failures | Requirement |  |  |
| Enhancement |  |  |
| SG.AU-6: Audit Monitoring, Analysis, and Reporting | Requirement | **X** |  |
| SG.AU-7: Audit Reduction and Report Generation | Requirement |  |  |
| SG.AU-8: Time Stamps | Requirement | **X** |  |
| Enhancement | **X** |  |
| SG.AU-9: Protection of Audit Information | Requirement | **X** |  |
| SG.AU-10: Audit Record Retention | Requirement |  |  |
| SG.AU-11: Conduct and Frequency of Audits | Requirement |  |  |
| SG.AU-12: Auditor Qualification | Requirement |  |  |
| SG.AU-13: Audit Tools | Requirement |  |  |
| SG.AU-14: Security Policy Compliance | Requirement |  |  |
| SG.AU-15: Audit Generation | Requirement | **X** |  |
| SG.AU-16: Non-Repudiation | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Security Assessment and Authorization (SG.CA)** | | | |
| SG.CA-1: Security Assessment and Authorization Policy and Procedures | Requirement |  |  |
| SG.CA-2: Security Assessments | Requirement | **X** |  |
| SG.CA-3: Continuous Improvement | Requirement |  |  |
| SG.CA-4: Information System Connections | Requirement | **X** |  |
| SG.CA-5: Security Authorization to Operate | Requirement |  |  |
| SG.CA-6: Continuous Monitoring | Requirement | **X** |  |
| **Configuration Management (SG.CM)** | | | |
| SG.CM-1: Configuration Management Policy and Procedures | Requirement |  |  |
| SG.CM-2: Baseline Configuration | Requirement | **X** |  |
| SG.CM-3: Configuration Change Control | Requirement | **X** |  |
| SG.CM-4: Monitoring Configuration Changes | Requirement | **X** |  |
| SG.CM-5: Access Restrictions for Configuration Change | Requirement |  |  |
| SG.CM-6: Configuration Settings | Requirement | **X** |  |
| SG.CM-7: Configuration for Least Functionality | Requirement | **X** |  |
| SG.CM-8: Component Inventory | Requirement | **X** |  |
| SG.CM-9: Addition, Removal, and Disposal of Equipment | Requirement | **X** |  |
| SG.CM-10: Factory Default Settings Management | Requirement | **X** |  |
| SG.CM-11: Configuration Management Plan | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Continuity of Operations (SG.CP)** | | | |
| SG.CP-1: Continuity of Operations Policy and Procedures | Requirement |  |  |
| SG.CP-2: Continuity of Operations Plan | Requirement |  |  |
| SG.CP-3: Continuity of Operations Roles and Responsibilities | Requirement | **X** |  |
| SG.CP-4: Continuity of Operations Training | Requirement | **X** |  |
| SG.CP-5: Continuity of Operations Plan Testing | Requirement |  |  |
| Enhancement |  |  |
| SG.CP-6: Continuity of Operations Plan Update | Requirement |  |  |
| SG.CP-7: Alternate Storage Sites | Requirement |  |  |
| Enhancement |  |  |
| SG.CP-8: Alternate Telecommunication Services | Requirement |  |  |
| Enhancement |  |  |
| SG.CP-9: Alternate Control Center | Requirement |  |  |
| Enhancement |  |  |
| SG.CP-10: Smart Grid Information System Recovery and Reconstitution | Requirement |  |  |
| Enhancement |  |  |
| SG.CP-11: Fail-Safe Response | Requirement | **X** |  |
| **Identification and Authentication (SG.IA)** | | | |
| SG.IA-1: Identification and Authentication Policy and Procedures | Requirement |  |  |
| SG.IA-2: Identifier Management | Requirement | **X** |  |
| SG.IA-3: Authenticator Management | Requirement | **X** |  |
| SG.IA-4: User Identification and Authentication | Requirement | **X** |  |
| SG.IA-5: Device Identification and Authentication | Requirement | **X** |  |
| Enhancement |  |  |
| SG.IA-6: Authenticator Feedback | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Information and Document Management (SG.ID)** | | | |
| SG.ID-1: Information and Document Management Policy and Procedures | Requirement |  |  |
| SG.ID-2: Information and Document Retention | Requirement |  |  |
| SG.ID-3: Information Handling | Requirement |  |  |
| SG.ID-4: Information Exchange | Requirement |  |  |
| SG.ID-5: Automated Labeling | Requirement |  |  |
| **Incident Response (SG.IR)** | | | |
| SG.IR-1: Incident Response Policy and Procedures | Requirement |  |  |
| SG.IR-2: Incident Response Roles and Responsibilities | Requirement |  |  |
| SG.IR-3: Incident Response Training | Requirement |  |  |
| SG.IR-4: Incident Response Testing and Exercises | Requirement |  |  |
| SG.IR-5: Incident Handling | Requirement |  |  |
| SG.IR-6: Incident Monitoring | Requirement |  |  |
| SG.IR-7: Incident Reporting | Requirement |  |  |
| SG.IR-8: Incident Response Investigation and Analysis | Requirement |  |  |
| SG.IR-9: Corrective Action | Requirement |  |  |
| SG.IR-10: Smart Grid Information System Backup | Requirement |  |  |
| Enhancement |  |  |
| SG.IR-11: Coordination of Emergency Response | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Smart Grid Information System Development and Maintenance (SG.MA)** | | | |
| SG.MA-1: Smart Grid Information System Maintenance Policy and Procedures | Requirement |  |  |
| SG.MA-2: Legacy Smart Grid Information System Updates | Requirement |  |  |
| SG.MA-3: Smart Grid Information System Maintenance | Requirement | **X** |  |
| Enhancement |  |  |
| SG.MA-4: Maintenance Tools | Requirement |  |  |
| SG.MA-5: Maintenance Personnel | Requirement |  |  |
| SG.MA-6: Remote Maintenance | Requirement | **X** |  |
| Enhancement |  |  |
| SG.MA-7: Timely Maintenance | Requirement |  |  |
| **Media Protection (SG.MP)** | | | |
| SG.MP-1: Media Protection Policy and Procedures | Requirement |  |  |
| SG.MP-2: Media Sensitivity Level | Requirement |  |  |
| SG.MP-3: Media Marking | Requirement |  |  |
| SG.MP-4: Media Storage | Requirement |  |  |
| SG.MP-5: Media Transport | Requirement |  |  |
| SG.MP-6: Media Sanitization and Disposal | Requirement |  |  |
| **Physical and Environmental Security (SG.PE)** | | | |
| SG.PE-1: Physical and Environmental Security Policy and Procedures | Requirement | **X** |  |
| SG.PE-2: Physical Access Authorizations | Requirement |  |  |
| SG.PE-3: Physical Access | Requirement |  |  |
| Enhancement |  |  |
| SG.PE-4: Monitoring Physical Access | Requirement | **X** |  |
| SG.PE-5: Visitor Control | Requirement |  |  |
| SG.PE-6: Visitor Records | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| SG.PE-7: Physical Access Log Retention | Requirement |  |  |
| SG.PE-8: Emergency Shutoff Protection | Requirement |  |  |
| SG.PE-9: Emergency Power | Requirement |  |  |
| Enhancement |  |  |
| SG.PE-10: Delivery and Removal | Requirement |  |  |
| SG.PE-11: Alternate Work Site | Requirement |  |  |
| SG.PE-12: Location of Smart Grid Information System Assets | Requirement |  |  |
| Enhancement |  |  |
| **Planning (SG.PL)** | | | |
| SG.PL-1: Strategic Planning Policy and Procedures | Requirement |  |  |
| SG.PL-2: Smart Grid Information System Security Plan | Requirement |  |  |
| SG.PL-3: Rules of Behavior | Requirement |  |  |
| SG.PL-4: Privacy Impact Assessment | Requirement |  |  |
| SG.PL-5: Security-Related Activity Planning | Requirement |  |  |
| **Security Program Management (SG.PM)** | | | |
| SG.PM-1: Security Policy and Procedures | Requirement |  |  |
| SG.PM-2: Security Program Plan | Requirement |  |  |
| SG.PM-3: Senior Management Authority | Requirement |  |  |
| SG.PM-4: Security Architecture | Requirement |  |  |
| SG.PM-5: Risk Management Strategy | Requirement |  |  |
| SG.PM-6: Security Authorization to Operate Process | Requirement |  |  |
| SG.PM-7: Mission/Business Process Definition | Requirement |  |  |
| SG.PM-8: Management Accountability | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| **Personnel Security (SG.PS)** | | | |
| SG.PS-1: Personnel Security Policy and Procedures | Requirement |  |  |
| SG.PS-2: Position Categorization | Requirement |  |  |
| SG.PS-3: Personnel Screening | Requirement |  |  |
| SG.PS-4: Personnel Termination | Requirement |  |  |
| SG.PS-5: Personnel Transfer | Requirement |  |  |
| SG.PS-6: Access Agreements | Requirement |  |  |
| SG.PS-7: Contractor and Third-Party Personnel Security | Requirement | **X** |  |
| SG.PS-8: Personnel Accountability | Requirement |  |  |
| SG.PS-9: Personnel Roles | Requirement |  |  |
| **Risk Management and Assessment (SG.RA)** | | | |
| SG.RA-1: Risk Assessment Policy and Procedures | Requirement |  |  |
| SG.RA-2: Risk Management Plan | Requirement |  |  |
| SG.RA-3: Security Impact Level | Requirement |  |  |
| SG.RA-4: Risk Assessment | Requirement |  |  |
| SG.RA-5: Risk Assessment Update | Requirement |  |  |
| SG.RA-6: Vulnerability Assessment and Awareness | Requirement |  |  |
| Enhancement |  |  |
| **Smart Grid Information System and Services Acquisition (SG.SA)** | | | |
| SG.SA-1: Smart Grid Information System and Services Acquisition Policy and Procedures | Requirement |  |  |
| SG.SA-2: Security Policies for Contractors and Third Parties | Requirement |  |  |
| SG.SA-3: Life-Cycle Support | Requirement |  |  |
| SG.SA-4: Acquisitions | Requirement |  |  |
| SG.SA-5: Smart Grid Information System Documentation | Requirement | **X** |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| SG.SA-6: Software License Usage Restrictions | Requirement |  |  |
| SG.SA-7: User-Installed Software | Requirement |  |  |
| SG.SA-8: Security Engineering Principles | Requirement | **X** |  |
| SG.SA-9: Developer Configuration Management | Requirement |  |  |
| SG.SA-10: Developer Security Testing | Requirement | **X** |  |
| SG.SA-11: Supply Chain Protection | Requirement |  |  |
| **Smart Grid Information System and Communication Protection (SG.SC)** | | | |
| SG.SC-1: System and Communication Protection Policy and Procedures | Requirement |  |  |
| SG.SC-2: Communications Partitioning | Requirement |  |  |
| SG.SC-3: Security Function Isolation | Requirement |  |  |
| SG.SC-4: Information Remnants | Requirement |  |  |
| SG.SC-5: Denial-of-Service Protection | Requirement |  |  |
| SG.SC-6: Resource Priority | Requirement |  |  |
| SG.SC-7: Boundary Protection | Requirement |  |  |
| Enhancement |  |  |
| SG.SC-8: Communication Integrity | Requirement |  |  |
| Enhancement |  |  |
| SG.SC-9: Communication Confidentiality | Requirement |  |  |
| Enhancement |  |  |
| SG.SC-10: Trusted Path | Requirement |  |  |
| SG.SC-11: Cryptographic Key Establishment and Management | Requirement | **X** |  |
| Enhancement |  |  |
| SG.SC-12: Use of Validated Cryptography | Requirement | **X** (recommendation) |  |
| SG.SC-13: Collaborative Computing | Requirement |  |  |
| SG.SC-14: Transmission of Security Parameters | Requirement |  |  |
| SG.SC-15: Public Key Infrastructure Certificates | Requirement | **X** |  |
| SG.SC-16: Mobile Code | Requirement |  |  |
| SG.SC-17: Voice-Over Internet Protocol | Requirement |  |  |

**Table (continued)  
Cybersecurity Requirements**

| **Smart Grid Cyber Security Requirements from NISTIR 7628** | | **Allocation of Requirements** | |
| --- | --- | --- | --- |
| **Contractor** | **Host Utility** |
| SG.SC-18: System Connections | Requirement | **X** |  |
| SG.SC-19: Security Roles | Requirement | **X** |  |
| SG.SC-20: Message Authenticity | Requirement | **X** |  |
| SG.SC-21: Secure Name/Address Resolution Service | Requirement |  |  |
| SG.SC-22: Fail in Known State | Requirement |  |  |
| SG.SC-23: Thin Nodes | Requirement |  |  |
| SG.SC-24: Honeypots | Requirement |  |  |
| SG.SC-25: Operating System-Independent Applications | Requirement |  |  |
| SG.SC-26: Confidentiality of Information at Rest | Requirement | **X** |  |
| SG.SC-27: Heterogeneity | Requirement |  |  |
| SG.SC-28: Virtualization Technique | Requirement |  |  |
| SG.SC-29: Application Partitioning | Requirement |  |  |
| SG.SC-30: Information System Partitioning | Requirement |  |  |
| **Smart Grid Information System and Information Integrity (SG.SI)** | | | |
| SG.SI-1: System and Information Integrity Policy and Procedures | Requirement |  |  |
| SG.SI-2: Flaw Remediation | Requirement | **X** |  |
| SG.SI-3: Malicious Code and Spam Protection | Requirement |  |  |
| SG.SI-4: Smart Grid Information System Monitoring Tools and Techniques | Requirement | **X** |  |
| SG.SI-5: Security Alerts and Advisories | Requirement |  |  |
| SG.SI-6: Security Functionality Verification | Requirement | **X** |  |
| SG.SI-7: Software and Information Integrity | Requirement | **X** |  |
| SG.SI-8: Information Input Validation | Requirement | **X** |  |
| SG.SI-9: Error Handling | Requirement |  |  |

**EXHIBIT A- 3 Project Description**

[Under Development]

1. Where neither “Contract” nor “Host Utility” are allocated a specific Requirement, parties will jointly discuss and mutually agree on the allocation of that Requirement. [↑](#footnote-ref-2)