Annex II: BESS Scope and Specifications

Contents

ABBREVIATIONS

AC	alternating current
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
BESS	battery energy storage system
BMS	battery management system
BOL	beginning of life
CPUC	California Public Utilities Commission
CT	combustion turbine
DC	direct current
DoD	depth of discharge
EMI	electromagnetic interference
EOL	end of life
EPO	emergency power off switchgear
EPRI	Electric Power Research Institute
ES	energy storage
ESD	electrostatic discharge
ESIC	Energy Storage Integration Council
ESS	energy storage system
EU	European Union
FMEA	failure modes and effects analysis
HV	high voltage
IEC	International Electro Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
kW	kilowatt
kWh	kilowatt-hour
L x W	length times width
MSDS	materials safety data sheet
MTBF	mean time between failures
MV	medium voltage
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
P&Q	active and non-active/reactive power
PCC	point of common coupling
PCS	power conversion system
RFP	request for proposal
RFQ	request for quotation
RoHS	Restriction of Hazardous Substances Directive
SDS	safety datasheets
SOC	state of charge
SOH	state of health
SOW	Statement of Work

THD	total harmonic distortion
UL	Underwriters Laboratories
UPS	uninterruptible power supply
WEEE	waste electrical and electronic equipment
XFMR	transformer

DEFINITIONS

- **BESS Energy Storage Capacity** means the aggregate net energy storage capacity (AC) of the BESS at the Electrical Interconnection Point, expressed in whole kWh (with a fractional kWh amount below 0.5 being rounded down to the nearest whole kWh and a fractional kWh amount equal to or above 0.5 being rounded up to the nearest whole kWh).

- **BESS Rated Power Rating** is the total possible instantaneous discharge capability (in kilowatts [kW] or megawatts [MW]) of the BESS, or the maximum rate of discharge that the BESS can achieve, starting from a fully charged state.

- **Storage duration** is the amount of time storage can discharge at its power capacity before depleting its energy capacity. For example, a battery with 1 MW of power capacity and 4 MWh of usable energy capacity will have a storage duration of four hours.

- **Cycle life/lifetime** is the amount of time or cycles a battery storage system can provide regular charging and discharging before failure or significant degradation.

- **Self-discharge** occurs when the stored charge (or energy) of the battery is reduced through internal chemical reactions, or without being discharged to perform work for the grid or a customer.
  Self-discharge, expressed as a percentage of charge lost over a certain period, reduces the amount of energy available for discharge and is an important parameter to consider in batteries intended for longer-duration applications.

- **State of charge**, expressed as a percentage, represents the battery's present level of charge and ranges from completely discharged to fully charged. The state of charge influences a battery's ability to provide energy or ancillary services to the grid at any given time.

- **Round-trip efficiency**, measured as a percentage, is a ratio of the energy charged to the battery to the energy discharged from the battery. It can represent the total DC-DC or AC-AC efficiency of the battery system, including losses from self-discharge and other electrical losses. Although battery manufacturers often refer to the DC-DC efficiency, AC-AC efficiency is typically more important to utilities, as they only see the battery's charging and discharging from the point of interconnection to the power system, which uses AC (Denholm 2019)

- **DoD** stands for "Depth of Discharge" which indicates how much of the battery's capacity has been used a discharge cycle

- **100% DoD cycles** mean a battery has gone through a complete discharge cycle, using 100% of its stored energy before being recharged, essentially representing a full cycle where the battery is fully depleted before being charged again.

1 GENERAL OVERVIEW

The purpose of this document is to present the specifications of New Battery Energy Storage System (BESS) for MEC.

1.1 General Description

1. The Scope of Work of this project is for the Engineering, Procurement, and Construction (EPC) of a 500 kW / 1,000 kWh grid connected, Lithium-ion battery energy storage project including Power Conversion System (PCS), Transformer, Cooling System, Battery Management System (BMS), Main control system. Contractor shall provide all labor, material, equipment, engineering, maintenance, and capital to design, install, commission, and interconnect a BESS as required herein (see Figure 1 BESS Interconnection Single Line Diagram (SLD))

2. Main Components and Subsystems of a BESS

Table 1 BESS Components and Subsystems

Component or subsystem	Notes
Battery	Batteries are usually built by stacking hermetically sealed battery cells to modules which are then stacked into series-connected battery "racks" which form an individual mechanical building block. A complete battery system is built by installing these racks in parallel in several DC circuits.
Power Conversion System (PCS)	Consists of one or more bidirectional AC/DC converters capable of managing the charging and discharging processes. The converters are controlled by centralized control system. The inverted are connected to a low voltage AC bus and directly to a same DC bus with the batteries.
Transformer	Step-up transformers are required to connect the PCS converters to medium voltage, which is typical in installation of various megawatts. The PCS converters' contractual connection point can also be the on the low voltage, where the transformer is not needed.
Cooling System	HVAC or liquid-cooling chiller system is cooling the batteries and/or PCS converter. During high charge/discharge powers (when batteries have their maximum heat emissions), the auxiliary power consumption especially to convey the heat away from the batteries can be the dominating auxiliary power consumer.
Switchgear and fusing	Depending on the protective requirements and the design, fusing can be found from individual battery racks, DC buses, individual converters and AC low voltage buses. The step-up transformers are connected to a medium voltage switchgear, which can provide one incoming feeder for the whole system.
Battery Management System (BMS)	The battery management system is usually distributed into various subsystems: there is monitoring logic into battery cell level, battery module level and typically on the rack level. These subsystems are coordinated by a main

Component or subsystem	Notes
	BMS which typically acts as the single communication interface for other systems.
Main control system	The main control system, sometimes referred to as Balance of Plant (BoP) system is the highest level of hierarchy in the local control. It controls the array of PCS converters, carries out all operation algorithms and works as an interface to the BMS (Battery Management System)

3. Summary of Key Specifications
   This summary is intended to assist vendors with identifying the key specifications for an ESS technology or project. Note that these summary specifications are also listed in the detailed line items in the following sections.

Table 2 BESS Summary of Key Specifications

Specification Parameter	Definition	Units	Value
Rated Continuous Discharge Power	The rate at which the ESS can continuously deliver energy for the energy storage component's entire *specified* SOC range.	kW	500
Rated Apparent Power	The real or reactive power (leading and lagging) that the ESS can provide into the AC grid continuously without exceeding the maximum operating temperature of the ESS.	kVA	500
Rated Continuous Charge Power	The rate at which the ESS can capture energy for the energy storage component's entire SOC range.	kW	500
Usable energy storage capacity	The accessible energy that can be provided by the ESS at its AC terminals when discharged at its beginning of life (BOL) and end of life (EOL).	kWh	1,000
AC Output Phases			3
Rated Continuous AC Current	The AC current that the ESS can provide into the grid continuously and can be charged by the grid continuously without exceeding the maximum operating temperature of the ESS.	A	Provided by supplier
Output Voltage Range	The range of AC grid voltage under which the ESS will operate in accordance with the ESS specification.	V	480
Voltage Unbalance Limit	Voltage unbalance requirements as per ANSI C84. 2006.	V	Provided by supplier
Current THD into Resistive Load (IEEE 519)	Total harmonic current of the ESS power output into a resistive load.	%	Provided by supplier
Rated Frequency	Rated frequency.	Hz	60
Output Frequency Range	The range of frequency under which the ESS will operate according to its specification.	Hz	Provided by supplier
Total Response Time	The response time shall be measured in accordance with figure below starting when the signal (command) is received at the ESS boundary and continuing until the ESS discharge power output (electrical or thermal) reaches 100 ± 2% of its rated power.	chart	Provided by supplier

Specification Parameter	Definition	Units	Value
System Round Trip Efficiency	Total round-trip efficiency from beginning of life (BOL) to end of life (EOL), defined as the ratio of the delivered output energy of the energy storage system to the absorbed input energy required to restore it to the initial state of charge under specified conditions.	%	Provided by supplier
Ramp Rate	The maximum rate, expressed in megawatts per minute, that the ESS can change its input and output power. This may vary in multiple dimensions such as state of charge (SOC) and/or other parameters of the system that may be broken out into multiple line-item values,	MW/min	Provided by supplier
Enclosure Type	A description of the system enclosure including that supplied with the system, provided as a part of the site installation and/or comprised of building assemblies associated with the installation. Examples include building, containerized–both stationary and transportable.		Provided by supplier
Equipment Footprint	Length x Width (LxW) of equipment only (Includes ESS and all ancillary units as required) in intended layout.	m^2	Provided by supplier
Height	Equipment height plus safe clearance distances above the equipment.	m	Provided by supplier
Weight	Weight per individual sub-system (PCS, ESS, accessories, etc.), including maximum shipping weight of largest item that will be transported to the project site.	kg	Provided by supplier
Grid Communication Protocols/Standards	List of codes/standards with which the ESS is compliant.		Provided by supplier
Rated Discharge Energy	Specify the accessible energy that can be provided by the accessible energy that can be provided by the ESS at its AC terminals when discharged at its beginning of life (BOL) and end of life (EOL).	kWh	Provided by supplier
Minimum Charge Time	The minimum amount of time required for the ESS to be charged from minimum SOC to its rated maximum SOC.	Hr.	Provided by supplier
Typical Recharge Time	This should include any time for rest a period needed between a full or partial charge or discharge cycle.	Hr.	Provided by supplier
Warranty & Replacement Schedule	Specify warranty inclusions and exclusions, include replacement schedules. Include timespan of warranty and any limitations.		Provided by supplier
Expected Availability of System	Percentage of time that the system is in full operation performing application specific functions taking into account both planned and unplanned down-time.	Hr./yr	Provided by supplier

4. BESS Project Description:
    1. The Contractor shall include BESS submittals in the proposal phase, including:
        a. A site plan showing the BESS footprint

b. Electrical schematic diagrams (interconnection, system one-line diagrams)
c. Usable energy storage capacity (kWh)
d. Rated power (kW AC)
e. AC:AC efficiency (including auxiliary loads)
f. Cycle life
g. Annual degradation factor
h. Ambient temperature control system
i. Fire protection/suppression system description as required by code
j. Equipment manufacturers and product names
k. Battery Management System provider
l. Maintenance requirements

2. The Contractor shall identify an appropriate location for the balance of system enclosure, and its related components and environmental control systems that will meet the following criteria:
   - Ease of maintenance and monitoring
   - Efficient operation
   - Low operating losses
   - Secured location and hardware
   - Compatibility with existing facilities
   - Minimum vegetative and landscape impact

3. All Balance of Systems (wiring, component, conduits, and connections) shall be suited for conditions for which they are to be installed.

4. Electricity from the BESS must be provided at 60 Hertz and at the appropriate voltage for electrical interconnection to the Site at 13.8 kV on the electrical distribution system. The BESS will interconnect at New Switching Station.

5. The BESS, and associated equipment, shall be provided in self-contained National Electrical Manufacturers Association (NEMA) enclosure(s) rated for the site conditions. BESS enclosures will be installed on a concrete pad constructed by Contractor at MEC Power plant. Contractor provided thermal conditioning systems shall maintain ambient temperature within warranty requirements. Contractor shall implement the project using a non-occupiable, containerized solution specified in section 6.0 Non-Occupiable Container Requirements.

6. BESS components and associated ancillary equipment shall have working space clearances required by local code, and electrical circuitry shall be within weatherproof enclosures marked with the environmental rating suitable for the type of environment in compliance with NFPA 70.

7. Data Acquisition and Monitoring
   Contractor shall provide a turnkey data acquisition and display system that allows MEC to monitor, diagnose, and track the charging, discharging, and operating data of the BESS. Monitoring and tracking systems shall include a historical database and real time data portal capturing the data in 15-minute intervals. A minimum of 36 months of data shall be stored by the Contractor and be made available for MEC download via the web portal. The data shall, at a minimum, comprise the following information and frequency of collection:
   - Date, time.
   - Apparent power (kVA)/phase, real power (kW) and Volts on each phase; recorded in 15-minute intervals.
   - BESS state of charge

- Ambient temperature, hourly average at hourly intervals, either from on-site measurements or a reliable climate data service.
- Wind speed at the array, at hourly intervals [optional, not required for performance assessment].
- The web-based monitoring system shall report actual system performance and an estimate of expected performance.

8. The Contractor must provide the following related to the BESS Safety
   A. The BESS shall have a Data Acquisition/monitoring/alarm system. System shall be described in the offeror's proposal and shall include:
   B. Full monitoring of electrical power and related operational data, including voltage, current, and system temperature.
   C. Visual and audible alarm if potential safety hazard exists.
   D. Notification of when preventive maintenance is needed.
   E. System level alerts shall be provided by the manufacturer over customer interface.
   F. The BESS shall contain protective relays, circuit breakers, or fuses which self-protect the BESS in the case of internal electrical faults. Set and adjust circuit protection devices according to a short circuit and coordination study.
   G. A detailed plan surrounding battery cell thermal runaway detection and mitigation systems in the BESS will be included in the submittal process.
   H. A visible disconnect will be installed that isolates BESS in accordance with utility interconnection requirements.
   I. All electrical equipment, enclosures, disconnects, and overcurrent devices shall be clearly marked and identified. Markings shall reference the same designations called out in the final design drawings.

9. A fire detection/suppression system shall be provided as required by code or by manufacturer.

10. Develop posted instructions for tasks that site staff may need to perform, such as system shutdown during an emergency.

11. Contractor shall provide 2 year of turnkey BESS maintenance and warranty service.

12. Contractor is responsible for all permits, approvals, environmental compliance, freight, financing, procurement, monitoring, site inspection, billing, and incidentals as necessary to design, construct, and interconnect the complete BESS, described hereinafter.

13. Contractor shall provide and install fire suppression system and observe guidelines from the National Electrical Code (NEC) 2017 and the International Association of Firefighters.

14. Contractor shall also provide pricing options to implement the project based upon:
   A. Contractor furnishing all project equipment including batteries, and
   B. Main power transformers, batteries, battery racks, and BMS equipment supplied as Company Furnished equipment to be integrated by the Contractor into a turn-key installation.

1.2 Single Line Diagram

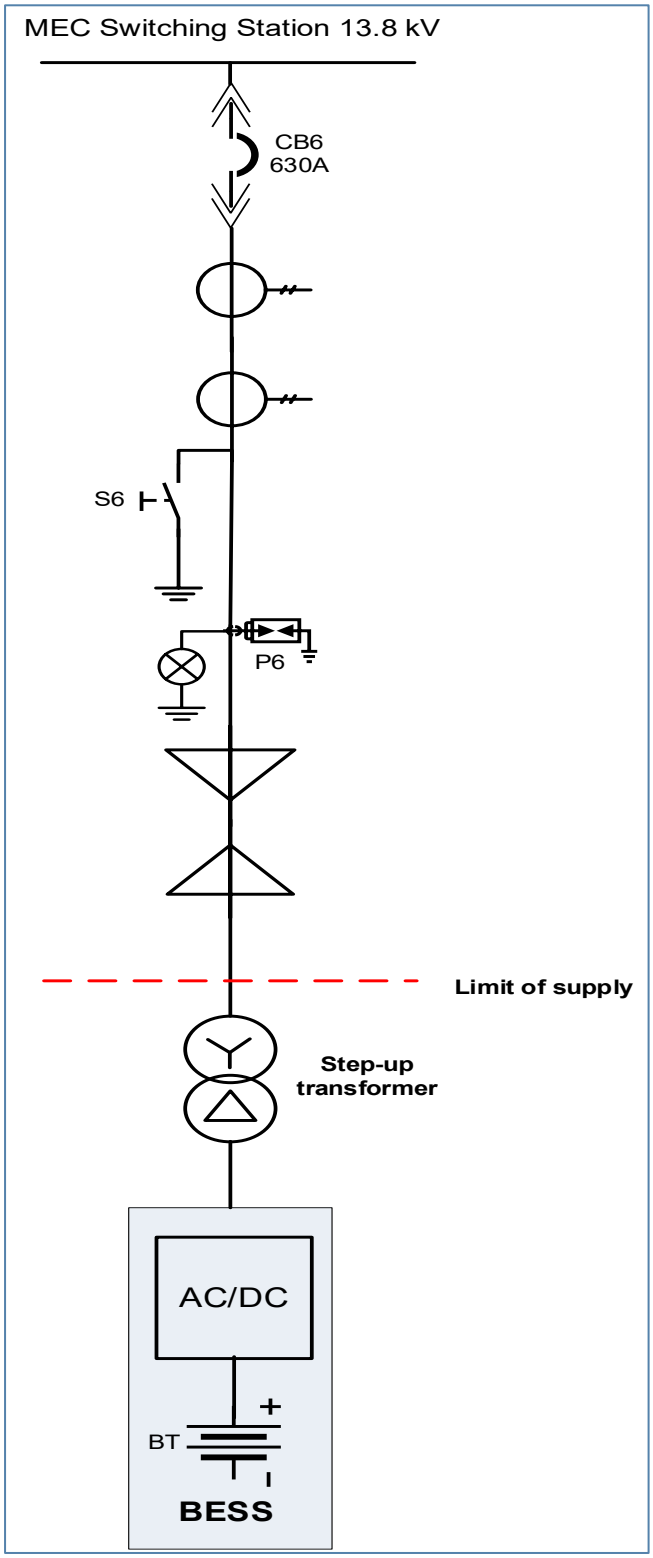

Figure 1 BESS Interconnection Single Line Diagram (SLD)

1.3 Work Included in Contractors Scope

Contractor's scope shall include but not be limited to the following:

A. Site Preparation and Utility tie-ins
B. All required foundations & civil work
C. Design, Furnish and install Battery Energy Storage System (BESS) non-occupiable equipment enclosures including:
    1. Lighting, raceway, and auxiliary systems
    2. HVAC/Cooling system
    3. Off-gas detection, Fire detection & suppression system as applicable
D. Design, Furnish and install Battery Energy Storage System (BESS) equipment including:
    1. Batteries, Racks, and BMS equipment
    2. DC main disconnects
    3. DC bus / cable interconnections between racks and disconnect
    4. Bi-directional inverters
    5. Metering, Relaying and Protection Panels, as required
    6. Auxiliary electrical distribution system and cabling
    7. Grounding Transformers (As Required)
E. Design, Furnish and Install an AC collection system including cable, raceway and transformers AND/OR DC Link/coupling system if connected to an existing inverter(s) at a renewable facility.
F. Design, Furnish and Install a new utility switchyard/substation or the modifications that are required to interconnect the BESS to an existing switchyard/substation including [but not limited to] MV or HV breakers and disconnects, surge arresters, grounding transformers, CTs and VTs, etc. (CONFORM TO APPLICATION)
G. Design, Furnish and Install all required metering, telemetry, and Site Controller equipment including any required modifications to the existing telemetry hardware and software.
H. Perform start-up checks utilizing OEM factory representatives as required and commission the facility.
I. Complete, perform & provide all applicable NERC testing and compliance reports for review by Company. Reports shall provide NERC related support documentation in a manner that is thorough, well organized, complete, and include explanations that support the conclusions reached.

1.4 Work Not in Contractor's scope

The basis of Contractor's bid shall be to provide a turnkey installation including main power transformers, batteries, racks, and the Battery Management System (BMS).

Contractor shall also provide pricing to implement the project incorporating Company-furnished main power transformers, batteries, racks, and BMS.

1.5 Permits and Agreements

A. Company will obtain --
    1. Operating permits
    2. Building Permits
    3. Construction Permits
    4. Local Permits
    5. Utility Interconnection Agreement
    6. Land Use and Rights-of-Way
    7. Environmental permits
B. Contractor shall obtain and pay for –
    1. Licenses as required for engineering and construction activities

1.6 Equipment

A. Design equipment in accordance with generally accepted industry standards for energy storage facilities.
B. Systems and operations shall be designed in compliance with equipment OEM's requirements and applicable industry standards.
C. Equipment shall be of proven design. Experimental, prototype, or one-of-a-kind designs are not acceptable.
D. Permanent equipment shall be new and unused.

- OEM shall be able to demonstrate at least 5 installations of comparable size (with similar conditions to RMI) which have achieved commercial operation as defined by the owning utility or Power Purchase Agreement (PPA) off taker.

E. Contractor shall verify that all equipment procured as part of this contract shall comply with Standards indicated in section 1.8

1.7 Use and Operation

A. Method of usage to be one full charge/discharge cycle per day with 365 full cycles per year. Up to two and a half (2.5) times as many recommended cycles can be expected in any 48-hour period, i.e. two full cycles in one day with rest to finish out 48-hour period.
B. Project to be designed for full nameplate capacity at Commercial Operation Date. Contractor shall provide the OEM's annual battery life degradation schedule and curves for expected use scenario and an additional schedule and curves based on 10% over cycling per year, and 20 periods of 10% over cycling per 48-hour period over a year (396 cycles per year).

1.8 Codes, Standards, and Regulations

Contractor shall, to the maximum extent feasible, be in compliance with one of the nationally recognized model building codes and with other applicable national, state, and local codes.

The latest edition of the local and nationally recognized codes and any updated supplements in effect at the time of contract award shall be used throughout the project design and construction. Codes and standards applicable to the BESS project can be found below.

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

i. All work must follow current National Electrical Code requirements:
   - NFPA 855, "Standard for the Installation of Stationary Energy Storage Systems"
ii. Battery cell:
   - UL 1642 "Standard for Lithium Batteries"
iii. Battery module:
   - UL 1973 "Batteries for Use in Light Electric Rail Applications and Stationary Applications"
iv. Battery system:
   - UL 9540 "Energy Storage Systems and Equipment"
   - UL 9540A "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems"
v. Grid interconnection standards, as applicable to the project as a whole:
   - Institute of Electrical and Electronics Engineers (IEEE) 1547
   - UL 1741, "Standard for Static Inverters and Charge, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"

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

vi. Other codes and standards that will apply include:
- UN 38.3 “Certification for Lithium Batteries” (Transportation)
- American National Standards Institute (ANSI) C12.1 (electricity metering)
- American Society of Civil Engineers (ASCE)-7 Minimum Design Loads for Buildings and Other Structures
- IEEE 2030.2, Guide for the Interoperability of Energy Storage Systems Integrated with the Electric Power Infrastructure

vii. (Alternative International Electrotechnical Commission [IEC] standards where applicable:
- IEC 62619
- IEC 63056
- IEC 62933-5-2)

2 PROJECT DESIGN CONDITIONS

2.1 Site Location / Interconnecting Provisions

Table 3 Site Location / Interconnecting Provisions

Project details	
Project Name	MEC BESS 500 kW/1,000 kWh
Company	MEC
Project Location	Majuro, Marshall Islands
Elevation	5,00
Energy Storage Capability at POI	1,000 kWh
HV/MV Interconnection Voltage	13.8 kV
LV Station Service Voltage	480 V
Point of Interconnection (POI)	(The electrical point of connection for which the performance requirement will be measured)

2.2 Site Conditions

Table 4 Site Conditions

Characteristic	Value
Ambient Temperatures	95°F (35°C) summer daytime (Max) 77°F (25°C) winter nighttime (Min)
Mean Daily Solar Exposure	53.8 kWh/sq. ft/ day (5 kWh/m^2/day)
Precipitation	Mean annual rainfall more than 118" (3000mm)
Humidity	Average relative humidity 80%
Mean Barometric pressure	14.6 psi (1009 hPa)
Design Wind Speed	157 ft/s (48m/s)

2.3 Site Arrangement

A. The detailed project arrangement shall be determined by the EPC Contractor in consultation with the Company's representatives.
B. BESS containers shall be separated from all structures, other BESS containers, and other equipment by a minimum of ten feet (10') of separation in accordance with NFPA 855.
C. The construction of the BESS must be carried out considering the design features and layout plan of new substation building and isolation transformers.

2.4 Seismic

Seismic loads and element design criteria shall be in accordance with applicable sections of the IBC, ASCE 7, AISC, and related or referenced documents for equipment, buildings, and structures.

2.5 Dead Loads

A. Dead loads shall be considered as being the weight of the structure and supported equipment of a permanent or semi-permanent nature including tanks, wall panels, partitions, roofing, piping, drains, electrical trays, and the contents of tanks measured at full capacity. However, the contents of tanks shall not be considered effective in resisting uplift.
B. Dead loads shall be determined using the minimum design dead loads and unit weights from the International Building Code (IBC and ASCE 7)

2.6 Live Loads

A. Live loads are produced by the use and occupancy of the building or structure including movable and transitory loads such as the weight of people, portable equipment, and tools; and mobile equipment or parts which may be moved over or placed on floors during maintenance operations.
B. The live loads used in the design of buildings and structures shall be the maximum loads likely to be imposed by the intended use or occupancy but shall not be less than the minimum live loads prescribed in the IBC and ASCE 7.

2.7 Soil and Hydrostatic Loads

A. The design of below-grade structures shall consider the effects of lateral soil pressures considering also appropriate allowances for possible surcharges due to adjacent fixed or moving loads.
B. Structures below the water table shall also be designed to resist the effects of hydrostatic pressure and buoyancy based on expected extreme groundwater conditions.

2.8 Wind Loads

A. Wind loads shall be computed in accordance with International Building Code (IBC and ASCE 7. A step function of pressure with height shall be used.
B. Design wind pressures shall be determined by applying velocity pressures for the design wind speed to the appropriate design equations for, respectively, the building or structure's main wind-force resisting system, other buildings, components and cladding, and for other construction considering the appropriate design coefficients and factors.

2.9 Rain Loads

A. Roofs and similar nearly horizontal surfaces shall be designed considering the potential ponding instability according to IBC and ASCE 7.

2.10 Construction Loads

A. The integrity of structures shall be maintained during construction without use of temporary framing struts, ties, or cable bracing insofar as possible.
B. Should construction or crane access considerations dictate the use of temporary structural systems; identify such situations and provide criteria that it intends to use to determine requirements for the temporary system.
C. Special consideration shall be given to ensure the stability and integrity of structures during any periods involving temporary bracing systems.
D. Assumed construction loads shall not be less stringent than those recommended in ASCE 7, International Building Code (IBC) or other generally recognized structure design agency

3 SCOPE OF WORK/DIVISION OF RESPONSIBILITY

3.1 General Description

A. Contractor’s Scope of Work includes design, engineering, procurement, construction, construction management, commissioning, startup, testing, demonstration testing and operator training.

B. If Company furnishes the main power transformers, batteries, racks, and BMS, Contractor shall also be responsible for receiving, unloading, storing, installing, checkout, commissioning, startup, and testing of Company-furnished equipment unless expressly stated otherwise.
C. For the avoidance of doubt, Contractor's scope includes all work necessary to provide a fully operational BESS facility except where explicitly noted otherwise.

3.2 Items Provided by Others

Items furnished by others and not in this scope of supply include the following:

A. Conceptual/Basic Layout
B. Potential for Company to directly purchase main power transformers,
C. batteries, racks, and BMS and free-issue to Contractor for installation and commissioning.
D. Permits as described in Section 1.0.

3.3 Safety Requirements

A. The Contractor shall comply with the Company's site safety requirements.
B. Contractor shall be responsible for site control as well as site safety training for any personnel that come onto the work site.
C. Report weekly on safety statistics including the number of safety walks, job safety assessments, and any incidents.

3.4 Electrical and Control

A. The electric system should be configured in a manner similar to the conceptual One- Line Diagram. The one-line should be considered conceptual in nature and is not intended to show all details required. The conceptual One-Line diagram is not intended to limit Contractor's flexibility in design.
B. Contractor's scope includes engineering, procurement, installation, and commissioning of the BESS scope including (MV) interconnect to an adjacent switchyard.

3.5 Civil / Structural

A. Contractor shall contract a 3rd party to perform a geotechnical investigation of the site. The design and installation of the facility shall be pursuant to the geotechnical report findings. A copy of the geotechnical report shall be made available to the Company.
B. Contractor is responsible to prepare the site as required. Contractor shall clear, grub, and perform earthwork activities as necessary to create a site that is suitable for construction.
C. Contractor is responsible to develop a site-specific storm water runoff plan and to protect the site against erosion during construction. The Contractor shall be responsible for final grading of site, maintaining the storm water drainage system, and completion of storm water drainage system in accordance with the site permits. Contractor shall obtain the stormwater permit and is responsible for closure of the stormwater permit.
D. Costs for the handling and disposal of any existing contaminated soils or other materials not identified in the soils report shall not be included in the Contract Price. Unforeseen conditions shall be treated as additional scope of work in accordance with the Contract documents.
E. Contractor is responsible to survey the site and establish site control geometry as necessary to perform the work. The survey data shall be provided as on-ground (surface) values with an equation to convert from ellipsoidal heights (State Plane Ground) to orthometric heights (State Plane Grid). Horizontal and vertical accuracy shall be Second Order Class II per the National Map Accuracy Standards (NMAS).
F. Dewatering and shoring of excavation works shall be the responsibility of the Contractor.

3.6 Engineering

A. Perform all engineering and design work required for a complete and operating facility, unless noted otherwise. Construction design documents shall be sealed by registered Professional Engineers licensed in the state where the project is located at.

B. Contractor shall provide a complete list of design deliverables with delivery dates to the Company.

3.7 Procurement

A. Except for equipment specifically listed as Company furnished, Contractor shall be responsible for the procurement of non-engineered equipment and engineered equipment, including freight to the site, unloading, and storage that is required to complete the project. Contractor shall also be responsible for unloading and onsite storage of any Company-furnished equipment.
B. Contractor shall procure all bulk materials whether intended for permanent installation or temporary installation that is needed for the erection of the systems and components.
C. The Contractor shall be responsible for performing the vendor shop inspections for the Contractor-furnished equipment. The Contractor's standard shop inspection reports shall be utilized and distributed to the Company. Notify Company of Factory Acceptance Tests (FAT) for equipment at least two weeks in advance of start of the FAT tests. The Company may elect to attend such tests at their cost and sole discretion, unless stipulated otherwise.
D. Submit to Company a binder and corresponding electronic files containing recommended operating spare parts lists including pricing, lead times, and contact information for equipment supplied by the Contractor. Company shall be able to purchase these spare parts from the Contractor or suppliers for the prices noted during the first year of operation.

3.8 Construction

A. Perform construction and erection work required for a complete operating facility, including management and responsibility for quality and time of performance for subcontracted work.
B. The Contractor shall be responsible for all indirect construction costs such as supervision, equipment, taxes, utilities, facilities, and other indirect items needed. This includes costs for personnel, construction equipment, including mobilization and demobilization, temporary buildings, temporary utilities, scaffolding, project job office expenses, employee travel and per diem expenses, and quality control testing, such as for concrete and welding.
C. Temporary construction office facilities, furnishings, janitorial services, and supplies shall be furnished by the Contractor.
D. Contractor shall provide temporary office space for two persons for use by Company and/or Company's representative during the period of site construction.

3.9 Special Inspections

A. The Company may engage one or more qualified Special Inspectors to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with other document requirements.
B. Requirements for the Contractor to provide quality-assurance and quality-control services are not limited by provisions of this Section.
C. The Contractor shall coordinate the inspection and testing services with the progress of the work. The Contractor shall provide notice to the testing agency to allow scheduling of personnel such that it does not create delays in work.
D. The Contractor shall be responsible for providing a BESS Hazard Mitigation analysis in accordance with NFPA-855 requirements for installations that meet Hazard Mitigation analysis criteria as described but not limited to NFPA-855 section 4.1.4.1.
E. The Contractor shall be responsible for costs of:
    1. Re-testing and re-inspection of materials, work, or products that do not meet the requirements of the Contract Documents and shop drawings / submittal data.
    2. Review of proposed repair and / or replacement procedures by the inspectors and testing agencies.
    3. Repair or replacement of work that does not meet the requirements of the Contract Documents, Special Inspector's, or AHJ's requirements.

3.10 Commissioning and Startup

A. Startup shall include activities, procedures, and tests required to bring installed systems and equipment to a state of readiness for Company acceptance and commercial operation. It is the Contractor's responsibility to comply with the battery manufacturer's requirements.
B. Contractor shall prepare written commissioning and testing procedures and submit for Company review and acceptance a minimum of 30 days prior to commencement of pre-commissioning tests.
C. Contractor shall comply with all interconnecting Utility requirements and/or system conditions that may be present.

3.11 Training

A. Contractor is responsible for training plant staff on the operation, maintenance, and repair of equipment furnished as part of the Works.
B. Training shall include both classroom and hands-on training for at least ten (10) persons.
C. Contractor shall allow Company representatives to shadow Contractor's startup personnel during commissioning activities. Participation by Company's trainees is at Company's option and does not relieve Contractor of responsibility to properly commission the facility.

3.12 Specifications and Standards

A. Reference to standards or manuals of any society, organization, or association, whether such reference be specific or by implication, shall mean the latest standard, manual, or code in effect as of the time of the Contractor's performance of the Work, unless specifically stated otherwise.
B. References to any standard or code and specifically to the International Building Code (IBC) shall mean the version of that code or standards adopted and modified by the local Authority Having Jurisdiction (AHJ).

4 SITE WORK

4.1 General

A. This section covers initial site work, maintenance of drainage systems during construction, and final site work.
B. The site grading and drainage plan shall conform to the requirements of the permits.
C. Site drainage facilities shall be designed to convey the runoff from a 4 percent probability (25 year) 24-hour storm event unless specific federal, state, or local regulations are more stringent.

4.2 Codes and Standards

Erosion and sediment control, grading, drainage, and storm water management; design, construction, and maintenance shall be in accordance with requirements set forth by state and local environmental management agencies and Environmental Protection Agency (EPA) and referred in IEE document for the project Can including the Environmental Management Plan 49450-040: Energy Transition Project

4.3 Fencing

A. A security fence at least 6 ft high with suitable gates shall be provided around the project site boundary during construction. Temporary or permanent fencing may be provided at Contractor's option.
B. Fencing shall be isolated or grounded at Contractor's option to ensure safety with respect to touch potentials. Special precautions shall be taken where fence abuts an existing electrical substation fence and near overhead transmission lines.
C. The permanent security fence shall have an overall height of approximately 8 feet including 3 strands of barbed wire mounted on 45-degree extension arms at top extending outward.
D. Other Applicable Company Standards

4.4 Dewatering

A. Contractor shall provide temporary dewatering if required for any work requiring excavation below the groundwater table.
B. The dewatering plan must be approved by the reviewing agencies prior to any dewatering activities being undertaken.

4.5 Grading and Drainage

A. The site shall be graded to convey storm water runoff away from permanent facilities. Minimum slopes shall be based on surface type. Provide a minimum 1 percent overall slope.
B. Areas that do not lend themselves to grading for surface drainage shall be provided with catch basins and underground piping. Maximum earth slopes shall be set based on slope stability and maintainability requirements. The steepest unimproved slope shall be limited to 3:1 height to vertical ratio.
C. Channels and ditches shall be designed and shown on the drawings.
D. Culverts shall generally be reinforced concrete, corrugated metal, or smooth-lined corrugated HDPE pipes.
E. Grating and guards shall be provided for fall protection at channels and ditches.

4.6 Heavy Loads

A. Contractor shall be responsible for repair of damage to any existing roads caused by hauling of battery containers, mobilization / demobilization of cranes, or other heavy loads.

4.7 Compaction

Unless the Contractor's geotechnical report allows for lower compaction requirements, the following minimums shall be adhered to. Submit for Company review any requests for alternative values.

Table 5 Soil Compaction

	Minimum Compaction in Accordance with ASTM D6981557 Standard Modified Proctor (%)
Unauthorized excavation	95
Fills and embankments	90
Trench subgrades	90
Trench subgrades beneath roads	95
Subgrades beneath roads	95
Structure backfill (around walls and structures)	95
Compacted sand fill	95
Trench backfill (crushed rock)	75 (relative density)
Trench backfill (cohesive and sand material)	90
Trench backfill (traversing paved areas)	95
Compacted rock fill	75 (relative density)
Structural fill (beneath structures)	98

4.8 Roads

A. Contractor shall be responsible for providing Buyer sufficient access to the site for the performance of routine maintenance and sufficient space within the facility during such times as not to interfere with Company activities.

4.9 Landscaping and Restoration

A. Provide finish landscaping for the site according to local ordinances and practices applicable to typical industrial facilities.

B. Areas of the site, including lay-down areas not specifically addressed by a landscaping plan or other requirements shall be restored to a condition acceptable to the Company as part of the demobilization from the site. This condition should also allow for closure of the Stormwater Permit.

4.10 Existing Conditions

A. This project may have below grade pre-existing conditions not indicated on any drawings, maps or other documents, or in locations different than where indicated.

B. Prior to any excavation activities, all known underground utilities shall be positively located using "soft dig" techniques to minimize the likelihood of a utility strike.

5 SUBSTRUCTURE REQUIREMENTS

5.1 General

Design and construct of reinforced concrete or other acceptable method to resist the loadings imposed by the building, structure, or equipment being supported.

5.2 Considerations

Foundation design shall consider the following:

1. Soil bearing capacities
2. Pile or pier capacities
3. Active, at-rest, and passive lateral earth pressures
4. Allowable settlements
5. Building, structure, equipment, and environmental loading
6. Equipment operating characteristics and performance criteria
7. Access and maintenance
8. Temporary construction loading

5.3 Analysis

A. Minimum factors of safety against overturning and sliding shall be 1.5 and 1.25, respectively, but in no case less than those prescribed by the International Building Code (IBC).

B. Geotechnical exploration, testing, and analysis information shall be used to determine the most suitable foundation system. Elastic (short-term) and consolidation (long-term) foundation settlements shall be calculated and limited to the following design values:
   1. Total settlement: 1.5 in
   2. Differential settlement: 0.1 percent slope between column support points

5.4 Slab-on-Grade

A. Care shall be taken to provide suitable base construction and to align and locate expansion and control joints as recommended in these references to minimize uncontrolled cracking.

B. Slabs-on-grade that are open or generally exposed to the environment shall be sloped to prevent the accumulation of standing water. Interior slabs do not require sloping.

5.5 Foundations

A. Prepare detailed foundation design criteria for each foundation type on the basis of on an independent geotechnical exploration program, performed by Contractor.

B. Interpretation or use of any preliminary boring information is solely the responsibility of the Contractor.

C. Foundations may be either cast in place or precast. All foundations shall be reinforced at a minimum to the temperature and shrinkage requirements of ACI 318.

D. Pile, post, or earth screw type equipment base foundations typically found in the renewable energy industry are acceptable alternatives to concrete foundations.
   Contactor shall provide safe access provisions to any equipment bases elevated above grade by more than the height of the equipment base.

5.6 Equipment Bases

A. Equipment bases may be site constructed of concrete, pre-fabricated concrete, or may be a structural metal skid furnished as part of the equipment.

B. Equipment bases shall consider all additional loads encountered during transport to the site and placement into final position.

6 NON-OCCUPIABLE CONTAINER REQUIREMENTS

6.1 General

A. This section covers the minimum requirements for containerized Battery Energy Storage Systems.
B. Containers should be shipped fully assembled to the extent practical, except for loading of the battery modules in the field.
C. Air conditioning units may be removed for shipment if required.

6.2 Materials

A. Container foundations may be formed in place concrete, pre-cast concrete, piers, or earth augers at the engineer of records option.
B. Foundations shall meet local building codes with respect to frost depth. Placement of containers directly on compacted fill is not allowed.
C. Container structural base may be pre-cast concrete or a structural steel system with steel decking.
D. Container walls and roof may be pre-cast concrete, steel, or hybrid construction.
E. All materials shall be non-flammable
F. Materials shall be suitable for a minimum 20-year lifetime.

6.3 Occupancy Class

A. It is the intent that containerized systems be classified as equipment enclosures rather than occupiable buildings.
B. The layout of equipment in containerized systems shall be such that personnel cannot occupy the enclosure. Containerized systems arranged to provide interior working space are strongly discouraged. If central aisle containers are provided, aisle width shall meet NEC required working space.
C. Access to battery modules and other equipment should be via doors arranged along the length of the container such that personnel are not required to enter the container to perform maintenance.

6.4 Partition Walls

A. If a skid assembly includes “central inverter” power conversion equipment and battery racks on a single skid, designs which include a fire-rated partition wall between batteries and power conversion equipment are preferred.

6.5 Windows

A. Windows are not required. Arrangements that allow the main DC disconnect position to be viewed or operated without opening doors are preferred.

6.6 Doors

A. Doors are not required for personnel ingress/egress.
B. Doors for equipment access should be provided along the long sides of the container. Doors arranged in “French Door” fashion are preferred.
C. Door opening width shall be as required to provide access to battery racks for module installation and removal.
D. Doors shall be lockable and keyed alike.
E. Exterior hardware shall be stainless steel.

6.7 Floor Coverings

A. Floors shall be non-combustible.

6.8 Fire Detection and Suppression

A. Containerized BESS systems shall be provided with fire detection systems as specified in 9.0 Fire Detection and Suppression.
B. Containerized BESS systems shall be provided with clean agent fire suppression systems as specified in 9.0 Fire Detection and Suppression.
C. Fire detection schemes incorporating early off-gas detection and interlock to shut down affected BESS equipment prior to fire or smoke detection are encouraged.

6.9 HVAC

A. HVAC systems shall be in accordance with 11.0 HVAC.

6.10 Security System

A. Security cameras shall be provided and located such that the entire site area is visible.
B. Security cameras shall be able to be monitored remotely at Company’s operations center

7 CONCRETE

7.1 General

Design and construct concrete structures in accordance with Building Code Requirements for Structural Concrete.

7.2 Codes and Standards

A. Specifications for materials shall generally conform to the standard specifications of the American Society for Testing and Materials (ASTM) and American Concrete Institute (ACI).
B. Field and laboratory testing procedures for materials shall follow standard ASTM specifications and the American Society for Nondestructive Testing (ASNT) procedures and practices.
C. Design loadings shall be in accordance with the loading criteria as stipulated in International Building Code (IBC).
D. Design and placement of structural concrete shall follow the recommended practices and the latest specifications and standards of the International Building Code (IBC).
E. Other recognized standards shall be followed where required to serve as guidelines for design, fabrication, and construction when not in conflict with the listed standards.
F. Other Applicable Company Standards

7.3 Design Criteria

A. Controlled Low-Strength Material (CLSM) can be used in nonstructural applications where limited strength is acceptable, its use would not be detrimental to the finished or adjacent construction and involves materials and placement methods commonly used and accepted in the region where the project is located.
B. Design concrete structures based on the following mix class:

Table 6 Concrete Mix class

Mix Class	Usage	Fc-28 Day Strength psi (bar)	Maximum Coarse Aggregate in. (mm)	Maximum Water to Cement Ratio
A-1	Lean concrete for work slabs (mud mats), fill, duct banks	2,000 (138)	3/8 (9.5)	0.55
B-1	General usage	4,000[1] (276)	¾ (19.1)	0.48
Grout		5,000 (345)		
CLSM	Selected nonstructural applications	300 max (21)		

Note 1 Strength shall be greater if required for durability per Chapter 4 of ACI 318

7.4 Materials

A. Refer to table for the material, application, and requirements that must be met:

Table 7 Material

Material	Application	Requirements
Cement	In accordance with mix design, local supply	ASTM C150, (Type as required by soil condition and exposure conditions).
Water	In accordance with mix design, local supply	Potable or non-potable

Material	Application	Requirements
Aggregate	In accordance with mix design, local supply	ASTM C33.
Fly Ash	In accordance with mix design, local supply	ASTM C618
Reinforcing steel, main reinforcing	No. 4 through No. 10	ASTM A615, Grade 60.
Reinforcing steel, ties and stirrups	No. 4	ASTM A615, Grade 60.
Forms	For exposed concrete surfaces except flatwork	Plywood or modular steel dimensions to nearest inch.

B. Ready-mixed concrete shall conform to ASTM C94.
C. Hot and cold weather concreting shall be in accordance with the recommendations of ACI.

7.5 Reinforced Applications

A. Suspended slabs shall be two-way reinforced; 0.75 in (19 mm) minimum cover; 6 in (150 mm) minimum thickness; steel trowel finish; sprayed with curing compound.
B. Structural Beams shall be singly or doubly reinforced; 0.75 in (19 mm) minimum cover for interior locations, 1.5 in (38 mm) cover for exterior locations; beam width in 2 in (50 mm) increments, minimum 8 in (200 mm); beam depth in 2 in (50 mm) increments, minimum 12 in (300 mm); cured at least 72-hours in forms.
C. Grade Beams shall be singly or doubly reinforced; 1.5 in (38 mm) cover; beam width coordinated with excavator characteristics, minimum 8 in (200 mm); 4 in (100 mm) minimum thickness void form below elements spanning between piers or piles.
D. Spread footings shall be 6 in (150 mm) increments for footing dimensions less than 9 ft (2.8 m); 3 in (75 mm) cover for sides and bottoms cast against soil; 1.5 in (38 mm) bottom cover when cast against working slab or mud mat.
E. Concrete strength determination shall be in accordance with ASTM C39.
F. Use Type V cement when high-sulfate resistance concrete is required. If not available provide written documentation of the unavailability, and then use of concrete Type I or Type II cement with a maximum tricalcium aluminate (C3A) content of 6 percent or less will be acceptable.

7.6 Finishes

A. Exposed Concrete Pads – Float Finish
B. Door Landing Stoops – Medium Broom Finish
C. Equipment Bases – Steel Trowel Finish
D. Steel troweled, surface hardened concrete shall be provided for exposed concrete construction in such areas as battery equipment areas, storage rooms, switchgear rooms, and mechanical rooms. Surface shall be non-slip; wet or dry.

7.7 Air-Entraining

A. Air-entraining agent shall be in accordance with ASTM C260.
B. Outdoor concrete shall include entrained air.

7.8 7.8 Grout

A. Use Portland, non-shrink cement for grout.
B. Metal shims shall be stainless steel.

8 METAL STRUCTURES

8.1 General

This section covers the minimum requirements for the design of metal framed structures and systems.

8.2 Codes and Standards

A. Design, fabrication, and erection of structural steel shall be in accordance with the recommended practices and specifications of:
   1. American National Standards Institute (ANSI)
   2. American Iron and Steel Institute (AISI)
   3. American Welding Society (AWS)
   4. American Society for Testing and Materials (ASTM)
   5. National Association of Corrosion Engineers (NACE)
   6. International Building Code (IBC)
   7. Occupational Safety and Health Association (OSHA)
   8. Other Applicable Company Standards

B. Other recognized standards shall be followed where required to serve as guidelines for design, fabrication, and construction when not in conflict with the listed standards.

C. The standards listed shall mean the latest version adopted by the state or local authorities including any amendments to, or modifications of the original document.

8.3 Design Criteria

A. Limit use of rigid frames to less critical applications such as pre-engineered metal buildings used primarily for enclosure purposes.

B. Utilize simple framing for such things as framed structures supporting equipment and utilities, either alone or in conjunction with enclosure materials.

C. Lateral forces imposed on buildings and structures shall be resisted through a system of horizontal and vertical bracing or horizontal diaphragms, and vertical bracing, shear walls or rigid frames.

D. Design member end connections for the forces and moments determined by engineering analysis.

E. Bolted connections shall be designed as bearing type with threads included in the shear plane except where slip-critical connections are required.

F. Bolted connections shall use 3/4 in (19 mm), 7/8 in (22 mm), or 1 in (25 mm) ASTM A325 (ISO R898 Class 8.8, or higher) bolts.

G. Large diameter or ASTM A490 (ISO R898 Class 10.9 or 12.9) bolts may be considered only when necessary to resist unusually large forces or reduce connection size.

H. Wedge anchors and epoxy or polymer mortared anchors shall be zinc plated or galvanized anchors are acceptable for interior applications; and stainless steel for exterior.

I. Anchor bolts installed during concrete placement shall be galvanized for their full length. Other materials may be used only as specifically approved by the Company.

J. Diagonal bracing that may impede equipment/material access is unacceptable

8.4 Deflection Guidelines

A. Floor or roof members supporting plaster ceilings or masonry walls; 1/360 times the span considering live load only.

B. Isolated structural members supporting masonry walls; the lesser of 1/600 times the span or 0.3 in (8 mm) considering dead plus live load.

C. For other members; 1/240 times the span, considering live load only.

D. Metal wall panel girts:
   1. Vertical; 1/240 times the span except the lesser of 1/960 times the span or 3/8 in (9.5 mm) where located under or over glass or masonry walls where clearance and load bearing capabilities are a consideration.
   2. Horizontal; 1/180 times the span except the lesser of 1/360 times the span or 1.33 in (33 .8 mm) when located under or over glass.

8.5 Lateral Drift Guidelines

A. The following guidelines for lateral drift of major structures shall be followed unless more stringent criteria are required by local building codes.
B. Braced frames shall be designed to resist the specified lateral environmental loads while limiting lateral deflection to 1/200 of the story or building height.
C. Moment resisting frames, such as those commonly used in pre-engineered metal buildings, shall be designed to resist 75 percent (corresponding to a 10 year recurrence interval) of the specified lateral environmental loads while limiting lateral deflections to 1/120 of the story or building height.
D. In structures without interior walls or other nonstructural components in contact with or supported by a building frame, lateral deflection may be increased to 1/50 of the story or building height considering the allowed reduction in lateral environmental loads.

8.6 Materials

A. Structural steel shapes, plates, and appurtenances for general use shall conform to the multi-certification requirements for ASTM A36/ASTM A572, Grade 50, or ASTM A992.
B. High strength connection bolts shall conform to ASTM A325. Other bolts shall conform to ASTM A307, Grade A.
C. Coat bolts for resistance to rusting for a minimum of 30 years.
D. Bolted connections shall conform to Specification for Structural Joints; ASTM A-325 or A-490 Bolts, current edition.
E. Bolt tightening/pre-tensioning shall be accomplished by use of load indicating washers or the turn-of-nut method. For bolts tightened by the turn-of-nut method, a minimum of 10 percent shall be checked using a calibrated torque wrench.
F. Anchor bolts shall conform to ASTM F1554, Grade 36 and shall be galvanized for their full length. Embedded shapes and plates shall be of ASTM A36 material and shall be galvanized.
G. Expansion and chemically bonded anchors shall be stainless steel conforming to ASTM A276 or ASTM A493.
H. Welding electrodes shall have a minimum specified tensile strength of 70,000 psi (4827 bar).
I. Outdoor structural steel shall be hot-dip galvanized. Galvanizing shall be in accordance with the requirements of ASTM A123, ASTM A153, and/or ASTM A525 as applicable.
J. Galvanized steel fabrication or modification performed on site shall be sent out for re-galvanizing whenever the work process can be revised to permit doing so without resulting in an unacceptable construction delay.
K. When offsite re-galvanizing is not feasible, field application of galvanizing material will be acceptable, subject to the Company acceptance and provided the effective thickness, adhesion, and durability of the field applied galvanizing method proposed can be shown to be at least equal to that of undamaged adjacent areas.
L. Field applied galvanizing paint will be acceptable for installation touchup and will be acceptable for galvanizing of field fabrication repairs or modifications only if conformance with the above requirements can be demonstrated.
M. Galvanizing of nuts, washers, and bolts shall be in accordance with ASTM B695.
N. Corrosion-resistant steel shall be used where corrosion or abrasion may be expected, thus requiring the use of special steels. Corrosion-resistant stainless steels shall conform to ASTM A213, Type 316L, 2.75 percent minimum molybdenum content; or ASTM 240, Type 304 / 304L as appropriate for the application.

8.7 Grating, Guards, Handrails, and Toe Plates

A. Steel grating shall be welded rectangular steel bar with bearing bars at least 3/16 in wide by not less than 1-1/4 in (32 mm) deep.
B. Guards, handrails, and toe plates for exterior shall be constructed of galvanized steel. Interior may be painted steel or galvanized. Steel guards and handrails shall be fabricated from 1-1/2 in (38 mm) nominal diameter, ASTM A53, round steel pipe with joints mitered and welded to form a continuous railing system.

C. Grating shall be hot dip galvanized steel except in corrosive environments; which shall be of fiberglass reinforced plastic construction. Grating ends shall be banded.
D. Guards for non-public locations shall be a two-rail system with the top rail 42 in (1067 mm) above the walkway surface and the intermediate rail 21 in (533 mm) below the top rail.
E. Guard post spacing shall be proportional to the length of the protected horizontal opening and shall consider the specified lateral loading but shall not exceed 6 ft (1800 mm) center-to-center.
F. Handrail for open sides of stairs in non-public locations shall be a combination guardrail/handrail system in which the top and intermediate rails are provided in accordance with the preceding and, in addition, with a handrail, offset from the plane of the guards toward the center of the stair run by distance required for hand clearance and with its top 34 in (860 mm) above the nose of the treads.
G. Provide toe-plates for platforms and stairways.

8.8 Stairs, Ladders, and Deck

A. Stair treads shall be galvanized assemblies of steel grating with cast abrasive nosing. Treads and riser proportions shall be in accordance with the IBC.
B. Exterior ladders shall be galvanized, interior may be painted steel; fabricated from ASTM A36 bar rails, 2-1/2 in by 1/2 in (64 x 13 mm), with 0.75 in (19 mm) diameter rungs inserted and plug welded into holes punched or drilled through the ladder rails. Ladder supports shall be spaced not more than 12 in (300 mm) vertically center-to-center.
C. Metal deck form shall conform to ASTM A446, Grade A or ASTM A611, Grade C. Metal deck shall be galvanized with a uniform coating having a weight of not less than 6 oz/sqft (316 g/sqm) on each surface.

8.9 Stenciling and Marking

A. Column identification by row letter and number shall be stenciled on four faces of exposed steel columns.
B. Letters and numbers shall be a minimum of 12 in (300 mm) tall.

9 FIRE DETECTION AND SUPPRESSION

9.1 General

A. Contractor shall be responsible to comply with all applicable fire and building Codes, including NFPA 855.
B. Contractor is advised that no source of water is available at the project site. If a water-based fire suppression system is required to meet local AHJ or Company's insurance requirements, Contractor shall design and install tankage and pumps as required
C. This section covers the minimum requirements for the fixed suppression systems, early warning detection systems, alarm systems, and portable fire protection equipment.
D. Contractor shall provide design, approvals, permits, installation, testing, and training for a complete, operational, and code compliant fire detection, alarm, and protection system(s). The design and record documents shall be sealed by a professional fire protection engineer registered in the jurisdiction in which construction occurs.
E. The fire protection and alarm systems and design requirements shall be based upon each BESS area being H3 occupancy per International Building Code (IBC).
Contractor shall confirm with code enforcement that this is the correct design.

9.2 Codes and Standards

A. Unless otherwise specified, the governing edition and addenda used shall be interpreted as the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply.
B. Any conflict between referenced codes or standards, or between the standards and these specifications, shall be referred in writing to Purchaser to determine which standard or specification requirements shall govern.

In addition to other codes and standards, design in accordance with Occupational Safety and Health Association (OSHA) and Americans Disabilities Act (ADA).

C. If not omitted by the local AHJ per allowance in NFPA-855, water-based system shall be in accordance with NFPA 13; the design occupancy classification shall be Extra Hazard Group 2 (EH2).
D. Clean Agent systems shall be in accordance with NFPA 2001 2018 and NFPA 855 200.
E. Other Applicable Company Standards
F. The following shall be followed:

Table 8 Codes and Standards

	Codes and Standards				
Description	Local & State Fire Code	Local & State Building Code	AHI	NFPA	UI, FM, ASME, ASTM, IEEE, AWS, AWWA and DOT
Overall design	X	X	X	X	
Fire detection system equipment components	X	X		X	X
Smoke/gas detection	X	X		X	
Heat detection	X	X		X	
Manual pull stations	X	X		X	
Notification/Indicating devices	X	X		X	
Sprinkler system	X	X	X	X	
Control panel initiating and indicating devices	X	X		X	
Pipe thread tolerances	X	X		X	
Hydrant flow tests	X	X	X	X	
Extinguishers	X	X		X	
Hose systems	X	X		X	
Fire alarm system wiring, initiating devices, notification appliances, solenoids, and signaling line circuits	X	X		X	
Testing of complete fire suppression and detection system	X	X	X	X	
Portable fire extinguishers	X	X	X	X	

9.3 Water-Based Systems

A. Water-based suppression requirements shall be provided in accordance with AHJ requirements, as NFPA-855 allows water-based suppression requirements to be omitted only if approved by the AHJ.
B. The sprinkler system shall be a double-interlock pre-action dry pipe sprinkler system with a minimum design density of 0.3 gpm/ft2 over 2500 ft2.
C. Piping systems shall be pressurized using air or nitrogen; and shall be constantly monitored. One of the following methods shall be employed.
    1. Method 1: K-factor of K-8.0 fused sprinkler heads with temperature rating of 135oF for heat detection. Activation of sprinkler head shall result in loss of pressure in the pipe,

thereby providing one of the two signals needed at the fire alarm panel. Photoelectric smoke detection shall provide the other needed signal, thus allowing water to flow into the piping system

2. Method 2: 135oF fixed electric temperature heat detectors will provide the initial signal as well as provide one of the two initiating signals needed to activate the pre-action sprinkler system. A K-factor of K-8.0 fused sprinkler heads with temperature rating of 145oF to 155oF shall provide the other required signal, thus allowing water to flow into the piping system. Water shall not be discharged into the area until the fixed heat detector and sprinkler head have activated. To ensure prompt recognition of a fire condition, the fixed electric heat detectors shall be spaced at half of their listed spacing (i.e.: A detector listed for 30ft spacing shall be installed at 15ft spacing).
3. Method 3: Use of Very Early Warning Air Sampling Smoke Detection System(i.e.: VESDA) with capability of providing two alarm points; one would be an initial general warning but it would not initiate the interlock system, the second alarm would be set equivalent to the set-point of a photoelectric smoke detector; which would be one of the initiating signals of the double interlock system. The second initiating signal shall be from Kfactor of K-8.0 fused sprinkler head with a set-point of 135oF. Linear heat detection may be considered if its use and installation is acceptable to the Authority Having Jurisdiction (AHJ).
4. Method 4: Use of Off-gas detection system as alternative to smoke detection as the pre-action signal if acceptable to the Authority Having Jurisdiction.

D. All methods shall be provided with manual pull (MP) stations. MPs shall act as an alternative for one of the input signals for the pre-action system. MPs shall be located and spaced per applicable codes, standards, and local requirements.
E. Contractor shall include all wiring necessary to provide a complete system fire protection system. Wiring shall include power wiring to connect the specified termination points on the fire protection and detection systems to the plant electrical power, tie-ins to plant systems, and tie-ins to outside agencies.
F. Contractor shall verify the fire water supply is adequate for the new fire protection system(s) by performing flow testing.
G. In areas that are not continuously occupied, automatic smoke detection shall be provided at the location of each fire alarm control unit(s). Where ambient conditions prohibit installation of automatic smoke detection, automatic heat detection shall be permitted.
H. Detailed drawings and calculations shall be provided for each system. Drawings and calculations shall be updated at the completion of the job to show as-built configuration. All drawing, calculations and submitted documents shall bear the seal of a registered professional engineer, in the state constructed.

9.4 Clean Agent System

A. Clean agent fire suppression system shall be FM200, NOVEC 1230, or equal. CO2 systems are not acceptable.
B. Non-occupiable container solution specified in Section 6.0 shall include a clean agent fire suppression system.

9.5 Valves

A. If valves are required as part of a water-based suppression system, valves installed between alarm initiating devices intended to signal activation of a system and the fire suppression system shall be electrically supervised.
B. Contractor shall verify that the design and physical locations of automatic or manual valves and piping network are acceptable to avoid hydraulic shock when the valves are actuated.
C. A permanently attached placard shall be provided on each valve indicating the location and hydraulic information.

9.6 Local Addressable Fire Alarm Control Panel

A. Local control panel(s) shall be furnished and installed to monitor systems. A minimum of one addressable local control panel shall be provided. A main fire control panel shall be located near facility main entrance. The main fire control panel shall monitor and

annunciate all fire signals. The main fire control panel shall include as a minimum a distinctive Alarm, Trouble and Supervisory LED for each suppression and detection system.

B. Main fire panel shall remotely transmit and annunciate all Fire, Trouble and Supervisory conditions to a manned location as designated by Company and as required per applicable codes, standards, and local requirements
C. Each local control panel shall be tagged and be capable of operation as a stand-alone system with its own internal secondary power via battery backup. Panel(s) shall communicate together via OEM's internal network communication system. Each initiating device shall be addressable and communicate to local panel via SLC circuit
D. The addressable local control panel(s) shall monitor and annunciate; alarms, trouble, and supervisory signals for each of the fire protection and detection devices and systems. The panel shall be of modular construction, front accessible, and wall mounted. In addition, the panel shall have a minimum of two spare alarm zones requiring only field wiring for future use.
E. Automatic pre-action valves shall be actuated (opened) electrically upon receipt at the panel of fire indication from the detection system for the given hazard, and the control panel shall concurrently produce a fire alarm and initiate any required auxiliary shutdown functions that may be specified or required per applicable codes, standards, and local requirements.
F. The panel for each clean agent or pre-action sprinkler system shall also continuously monitor the off-normal conditions necessary to ensure the availability and proper operation of each system and to annunciate distinctly supervisory and trouble alarms as appropriate.
G. The following distinctive alarms, as a minimum, shall be provided as applicable at the local panel for each pre-action sprinkler system: (Equivalent shall be provided for Clean Agent system and detection systems)

Table 9 Alarm Condition

Alarm Condition	Source	Type of Alarm
Fire detected	Heat detectors, smoke detectors, Very Early Air Sampling Smoke Detection, or Manual Pulls (Style D)	Fire
Solenoid energized (for automatic or remote manual systems only)	Local panel (Style B)	Fire
Water flow	Water pressure switch (Style B)	Fire
System isolation gate valve (or alarm isolation valve) not fully open	Tamper switches (Style B)	Supervisory
Header isolation gate valve not fully open*	Tamper switch (Style B)	Supervisory
Low air pressure in sprinkler piping	Air pressure switch (Style B)	Supervisory
High air pressure in sprinkler piping	Air pressure switch (Style B)	Supervisory
Solenoid trouble (automatic or remote manual systems only)	Open or ground in wiring to solenoid (Style B)	Trouble
Strobe or Fire alarm bell/horn circuit trouble*	Open or ground in wiring to notification device (Style Y)	Trouble
Water pressure switch circuit trouble	Open or ground in wiring to switch (Style B)	Trouble
Low air pressure switch circuit trouble	Open or ground in wiring to switch (Style B)	Trouble
High air pressure switch circuit trouble	Open or ground in wiring to switch (Style B)	Trouble
Fire detector or MP circuit trouble	Open or ground in detector wiring (Style D)	Trouble

Alarm Condition	Source	Type of Alarm
System isolation valve tamper switch circuit trouble	Open or ground in wiring to switch (Style B)	Trouble
Header isolation valve tamper switch circuit trouble	Open or ground in wiring to switch (Style B)	Trouble
Loss of primary power at panel/battery in use*	Local panel	Trouble
Battery voltage low	Low voltage in battery	Trouble
Battery short, charger, or wiring trouble	Open or ground in circuits	Trouble
System normal	Local panel	N/A
Lamp test	N/A	Switch
Acknowledge	N/A	Switch
System reset	N/A	Switch

*These alarms need not be duplicated when two or more suppression systems are controlled by one panel.

H. Actuating devices and relays shall be furnished to provide annunciation per applicable codes, standards, and local requirements. Spare capacity shall be provided and internally wired.
I. Each local control panel shall continuously monitor its associated fire suppression and/or detection system(s) for fire alarms, supervisory signals, and circuit trouble signals.
   1. Upon receipt of a fire alarm, the given panel shall activate appropriate system valves, auxiliary relay, strobes and fire alarm bells throughout the building.
   2. Upon receipt of a trouble or supervisory signal, the panel shall activate individual indicating LEDs on the panel and a trouble horn at or near the panel. Trouble and supervisory signals shall be distinctive, i.e., the mixing of two or more signals on one circuit is not allowed.
J. Auxiliary shutdown functions, where required, shall be designed, furnished, and installed, as a minimum, per applicable codes, standards, and local requirements.
K. New panels shall include 10 percent spare I/O of each type. Indicated potential future expansion out cannot be considered as part of the spare capacity to meet this requirement.
L. Wiring and raceway between local panel(s) and remote relay, where required for such things as HVAC systems for auxiliary contacts, will be furnished and installed.
   Remote shutdown devices shall be located within 3 ft from device/system being shut down. Fire Contractor shall clearly note termination points and wiring on the drawings so other Contractors will be able to land wiring on shutdown relays.
M. Fire protection wiring shall include surge protection, per applicable codes, standards, and local requirements.
N. Upon receipt of any fire alarm signal from a fire detector, suppression system, flow switch, or pull station, the local alarm panel shall activate interior and exterior fire alarm horns/strobes.

9.7 Fire Detection and Alarm

A. Each independent fire detection system shall be designed to provide fire detection, MP and annunciation in each of the areas protected.
B. Each detection control panel shall continuously monitor its detection systems for fire or trouble condition and activate the appropriate fire or trouble alarm(s). These detection and alarm functions shall be performed independently of any other plant equipment or facility. All signals shall be annunciated on main fire control panel.
C. Airflow, ceiling height and slope, and ceiling constructions of the protected area shall be evaluated when selecting spacing and location of detectors. Refer to NFPA 72 for location criteria.

D. HVAC duct detectors shall be provided in the duct and wired to the local fire protection panel to initiate the appropriate response per applicable codes, standards, and local requirements. The fire alarm shutdown contacts shall be installed in a junction box next to the HVAC controller. Refer to NFPA 90A.
E. All Wiring shall be installed in ridged metallic conduit.
F. As a minimum, the following shall be provided:
    1. Smoke, heat, and HVAC duct detectors.
    2. Manual Pull Stations
    3. Early Warning Air Sampling Smoke detectors and sampling pipe network, if this is the method utilized.
    4. Fire detection circuits, wiring, raceway, conduit and supports as required for a complete system.
    5. Local control panel with distinctive alarm, trouble and supervisory LED's.
    6. Remote shutdown relays i and junction boxes.
    7. Notification devices (i.e.: Strobes, horns and bells).
    8. Connecting wire and raceway for electrical devices.
    9. All field devices shall be installed in a junction box.
G. Each fire detection and alarm control panel shall be provided with the capability to send alarms for remote annunciation of fire and trouble alarms. The following distinctive alarms shall be provided for remote monitoring purposes from each of the local panel, as required.

Table 10 Fire Detection and Alarm

Alarm Condition	Source	Type of Alarm
Fire detected*	Area or duct smoke detector (Style B)*	Fire
Detector circuit trouble (short, open, or ground fault)	Panel (Style B)*	Trouble
Loss of ac power (battery in use)	Local panel	Trouble
Low or missing batteries	Low voltage in batteries/panel	Trouble
Battery short, charger, or wiring trouble	Open or ground in circuits	Trouble
Notification circuit trouble	Open or ground in wiring to indicating appliance	Trouble
System normal	Panel	N/A
Lamp test	N/A	Switch
Acknowledge	N/A	Switch
System reset	N/A	Switch
*NFPA Style D circuit, when detection is used as releasing device		

9.8 Fire Equipment

A. Fire hose stations shall be provided only if required by local AHJ or applicable codes, standards, and local requirements.
B. The Contractor shall furnish fire hose stations with fire hose, hose racks, and accessories per applicable codes, standards, and local requirements
C. Portable fire extinguishers shall be provided. Refer to NFPA 10 for extinguisher locations and spacing.
D. Submit certified drawings of fire hose stations, as applicable and portable fire extinguishers including dimensional data.

9.9 Materials

Table 11 Fire Equipment Material

Component	Material
PIPING	
Sprinkler piping (downstream of isolation gate valve)	ASTM A53, Grade A or B, galvanized, seamless or welded (ERW); or ASTM A106, Grade B, galvanized. Minimum Schedule 40
Pre-action systems (downstream of isolation gate valve)	ASTM A53, Grade A or B, galvanized; seamless or welded (ERW); ASTM A106, Grade B, galvanized (no copper or brass tubing or piping). Minimum Schedule 40
Piping (upstream of the sprinkler and spray systems)	Black steel, ASTM A53, Grade B, seamless; or ASTM A106, Grade B, seamless. Minimum Schedule 40
FLANGES	
Flanges	Hot-dip galvanized following welding when connected to galvanized pipe
Piping 2 in (50.8 mm) and smaller	Screwed or shop welded.
Piping larger than 2 in (50.8 mm)	Welded flanges or shop welded connections
PIPE ACCESSORIES	
Sprinkler fittings - threaded or flanged; tees, couplings, elbows, caps, and reducers	Malleable iron, Class 150. Mitered fittings are not acceptable.
Sprinkler fittings	Galvanized, ASTM A153; no bushing, slip type, or clamp- on rubber gasketed fittings
Gaskets	Red rubber sheets, 1/16 in (1.6 mm) thick, full face, ASTM D2000, No. 2AA705A13L14
Thread sealant	Teflon ribbon, Optional for gas suppression piping: Loctite 592 sealant and primer NF-73656
Thread tolerances	Local Fire Code and standard pipe threads
Bolts and nuts	Steel machine bolts
Plugs	Square heads and of a metal dissimilar to fitting to which they are attached
Piping supports	Per State and Local Fire Code
Supplementary support beams (pipe support)	ASTM A36, fireproof construction
Riser lugs	ASME B31.1
Hanger rods	Per Fire Code
Water shields	Viking model B-1, or equivalent.
VALVES	
Gate valves	OS&Y type, flanged ends
Control panels (local)	NEMA 4 or IP56

9.10 Testing

A. Contractor shall be present during testing. Contractor shall be responsible for costs associated with initial testing as well as costs to correct deficiencies and retest.
B. Contractor shall notify Company and AHJ (if required) at least 5 days in advance of beginning of each test. Final acceptance shall be determined by the Company.
C. Documentation of the inspections and tests shall be maintained by Contractor and furnished to Company. Defects found by these inspections and tests shall be reinspected following repair by the same method and technique which originally identified the defect.

Acceptance shall be based on identical acceptance criteria. Inspection and tests shall be in accordance with NFPA as a minimum. All parties necessary to sign off on test shall be obtained.

D. Testing shall be done by Contractor for:
    1. Testing and system acceptance of water-based fire protection systems
    2. Testing and system acceptance of fire alarm system
    3. Entire System
    4. Testing shall be performed on all piping and valves.
E. Piping and valves; each test shall be conducted for 2 hours at 200 psi (13.8 bar) or at 50 psi (3.5 bar) above the maximum static pressure, whichever is greater. The systems shall be visually inspected during the tests. There shall be no visible leakage or drop in gauge pressure during the tests.
F. The valves shall be tested along with the piping. Any blind flanges or removable plugs required for openings not closed by the valves and piping provided shall be furnished.
G. The pressurization equipment including water piping from the supply shall be furnished.
H. In addition to hydrostatic tests, perform air pressure tests on air pressurized piping and valves. Air pressure of 40 psi shall be established, and the pressure drop shall be measured. The pressure drop shall not exceed 1.5 psi (0.11 bar) in 24 hr.
I. The time to exhaust air and achieve continuous water flow shall not exceed 60 seconds.
J. Systems shall be tested in accordance with the manufacturer's recommendations and to verify proper alarm and annunciation.
K. Each control panel and independent detection system shall be tested in accordance with NFPA 72 after installation has been completed. Each initiating and notification device shall be checked for operation. Remote annunciation to main panel and to remote location shall be tested.
L. Testing of the detectors shall be by manufacturer's recommendations. Upon detector actuation, visual and audible annunciation of the independent detection system at the local and main fire control panel shall be verified. Each alarm circuit at the local and main fire control panel shall be tested to verify proper operation.

10 SPILL CONTAINMENT, AND FIRE WALLS

10.1 General

A. This section covers the requirements for spill containment and transformer fire walls.
B. At Contractor's option, transformers may be supplied with environmentally friendly less-flammable fluid (FR3, MIDEL 7131 or engineer approved equal) which may reduce spill containment and firewall requirements if approved by environmental permit. Contractor to verify fluid characteristics are appropriate for site environmental conditions.

10.2 Codes and Standards

A. Equipment, material, design, fabrication, erection, and testing shall conform to governing codes and standards, and minimum requirements of:
    1. International Building Code (IBC)
    2. Occupational Safety and Health Association (OSHA)
    3. American Society of Mechanical Engineers (ASME)
    4. American Society for Testing and Materials (ASTM)
    5. American Concrete Institute (ACI)
    6. American National Standards Institute (ANSI)
    7. State and Local Fire Code
    8. Environmental Protection Agency (EPA)
    9. Other Applicable Company Standards
    10. The standards listed shall mean the latest version adopted by the state or local authorities including any amendments to, or modifications of the original document.

10.3 Design Requirements

A. Design shall comply with requirements for civil, structural, piping, and fire protection systems.

10.4 Transformer Spill Containment

A. Spill containment for transformers shall be based on the number of gallons (liters) of oil/fluid in the transformer.
B. Design shall comply with requirements for environmental, civil, structural, and fire protection systems.
C. Containment shall be sized to retain any fluid that may be accidentally spilled from the transformer plus a specified storm event rainfall depth, plus any applicable fire water.
D. Containment may be combined to include multiple transformers or transformer areas; such that the containment meets requirements for the maximum containment needed for a single event.

10.5 Transformer Fire Walls

A. Refer to NFPA 850 for location and configuration of firewalls.
B. A minimum 2-hour fire barrier of appropriate height shall be provided between any transformer of sufficient oil volume and any building in accordance with applicable Codes or insurance requirements.
C. Adequate physical separation distance may be provided in lieu of fire barriers.
D. Transformers utilizing approved less-flammable fluids (e.g. FR3) shall follow minimum separation requirements of FM Global Loss Prevention Data Sheet 5-4.

11 HEATING, VENTILATION, AND AIR CONDITIONING

11.1 General

A. Heating, ventilating, and air conditioning (HVAC) systems shall be provided to ensure equipment OEMs' recommended environmental conditions are met at all times.
B. HVAC equipment and systems shall be heavy-duty, industrial grade design, construction, and installation designed to provide a minimum 20-year life expectancy.
C. Design calculations shall include air conditioning load calculations, heating load calculations, ventilation calculations, psychometric calculations, and pressure drop calculations.

11.2 Codes and Standards

A. Equipment, material, design, fabrication, erection, startup, and testing shall conform to governing codes and standards, and minimum requirements of:
    1. State Energy Conservation Codes
    2. International Building Code (IBC)
    3. Occupational Safety and Health Association (OSHA)
    4. American Society of Mechanical Engineers (ASME)
    5. American Society for Testing and Materials (ASTM)
    6. American National Standards Institute (ANSI)
    7. State and Local Fire Codes
    8. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
    9. Other Applicable Company Standards

11.3 Design Requirements

A. Cooling equipment capacity shall be sized based on end-of-life battery state-of health (70-80%) heat dissipation coincident with maximum design ambient heat gain.
B. Building or enclosure areas housing batteries shall be segregated into hot and cold aisles. Supply air measured at the battery rack cold aisle shall be maintained at 23C +/- 5C at all times, unless battery OEM specifically requires a different operating temperature. Each battery cold aisle temperature shall be measured at three locations equally spaced along the length of the row. Temperature sensors shall be located approximately 5 feet above the floor. All temperature measurements shall be recorded in the site data historian at 1-minute resolution. Data shall be stored a minimum of 6 months.

C. High efficiency filtration (80%, MERV 13) is required for HVAC units that provide a mixture of outside air and return air. For 100% recirculation style units only 30%, MERV 7 filters may be provided.
D. HVAC systems should be designed to operate in economizer (free cooling) mode whenever outdoor air temperature is within specified supply air temperature range.
E. Filter banks shall have differential pressure transmitters to monitor filter loading.
F. Heating calculations shall include a minimum 10% margin on capacity. Cooling calculations shall include a minimum 15% margin on sensible and latent capacity.
G. HVAC equipment shall be arranged to provide for maximum efficiency of operation and to provide easy access for performing routine maintenance.
H. System design shall be headered such that each HVAC unit is able to provide conditioned air to the entire space within a fire partition.
I. Equipment redundancy shall be provided such that failure of a single HVAC unit does not result in loss of more than 50% cooling capacity.
J. The HVAC control system shall monitor any equipment failures resulting in loss of cooling capacity. Diminished cooling capacity shall be interlocked with the Site Controller to limit battery charging/discharging rate as necessary to avoid cooling system overload. Battery state of health should be taken into consideration when developing charge/discharge rate limit.
K. The HVAC systems shall interface with fire protection systems in accordance with NFPA and other applicable codes. HVAC systems shall shut down and fire/smoke dampers shall close upon fire or smoke detection. Fire-fighting personnel shall be able to override system shutdown to ventilate the building space if required.

11.4 Testing

A. After installation, HVAC systems shall be functionally tested by NEBB certified technicians to verify proper operation.
B. Emphasis shall be placed on ensuring that cooling airflow is properly balanced to maintain cold aisle temperature within specified limits.
C. All temperature data points recorded in site data historian shall be functionally verified for proper operation.

12 GENERAL ELECTRICAL

12.1 General

A. This section describes the design criteria which shall be used for general electrical work related to this project.
B. Equipment and systems covered in this section are:
   1. Cable
   2. Earthing and Bonding
   3. Lightning Protection
   4. Conduit and Raceway
   5. Lighting and Wiring Devices

12.2 Codes and Standards

A. The Work shall be in accordance with applicable laws and regulations of the federal government and the state, local utility requirements for interconnection, and applicable local codes and ordinances. A partial listing of the codes and industry standards used for design and construction follow:
   1. National Electrical Code (NEC)
   2. International Building Code (IBC)
   3. American National Standards Institute (ANSI)
   4. Institute of Electrical and Electronics Engineers (IEEE)
   5. American Society for Testing and Materials (ASTM)
   6. Illuminating Engineering Society (IES)
   7. Occupational Safety and Health Association (OSHA)

8. Other Applicable Company Standards

B. Other recognized standards shall be utilized as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards.
C. The codes and industry standards used for design, fabrication, and construction shall be the codes and industry standards in effect at the date of this Contract.
D. The Company may be exempt from certain NEC requirements. The system electrical design shall be NEC compliant to the greatest extent possible and in accordance with all applicable standards. Deviations from the NEC must be approved by Company.

12.3 Cable Basic Requirements

A. Cable requirements are applicable to general (field) wiring only. Manufacturer's standard wiring practices are acceptable for equipment wiring.
B. Medium voltage cables shall be fully shielded and shields shall be grounded in accordance with IEEE 422.
C. Instrument cable shall be fully shielded to minimize electrical noise attenuation. Each pair of instrument conductors shall be shielded and each multi-pair cable assembly shall include an additional overall shield. Cable shields shall be electrically continuous. When two lengths of shielded cable are connected together at a terminal block, a point on the terminal block shall be used for connecting the shields. Instrument cable shields shall be grounded on one end only.
D. Medium voltage cable feeders along with their shields and equipment ground conductors shall be sized so that a short-circuit fault shall not result in cable damage prior to normal operation of fault interrupting devices.
E. Insulated conductors installed in cable tray shall have non-propagating and self-extinguishing characteristics. Cables shall meet the vertical cable tray flame test requirements of IEEE 383.
F. Thermocouple extension cable shall be used for extension leads from thermocouples to junction boxes and to instruments for measurements of temperature. Cables may be routed in trays, conduits, or ducts.
G. All cables shall be identified on each end with a unique cable ID and permanent cable tag.
H. Cable data such as year of manufacturing, manufacturer name, insulation material, rated voltage, and cross section shall be printed on the cable jacket at even spacing.
I. Cable conductor colors shall be in accordance with Company standards.

12.4 Power Cable

A. Medium voltage power cable shall be MV-105, 133% insulation, single copper or aluminum conductor, Class B stranded, shielded power cable. Cable shall meet AEIC CS8 and ICEA S-97-682 requirements and shall be UL listed for cable tray use. Cable shall meet the flame test requirements of IEEE 383.
B. Low voltage power cable shall supply power to loads at voltage levels of 480 volts ac and below and 250 volts dc and below. Power cable shall have XHHW or XHHW-2 Class B stranded copper conductor. Cable shall meet ICEA S-95-658 and shall meet the flame test requirements of UL VW-1 (8 AWG and smaller) and IEEE 383 (6 AWG and larger).
C. No MV cable splices are permitted unless explicitly approved by the Company.

12.5 Control and Instrumentation Cable

A. Control cable shall be used for control, metering, and relaying. Control cable shall have Class B stranded copper conductor, flame retardant insulation, flame and ultraviolet retardant overall jacket and shall be UL listed Type TC. Cable shall meet ICEA S-95-658 and UL 1277. The cable shall meet the flame test requirements of IEEE 383.
B. Control shall be multi-conductor and shall be UL listed Type TC.
C. Instrumentation cable shall be single or multi twisted pair or triad and shall be UL listed Type PLTC.
D. Metering and Relaying panel conductors shall be type SIS #14 AWG minimum or #12 AWG minimum for CT circuits .

12.6 Lighting and General Use Conductors

A. Insulation shall be rated 600 volt. Circuit runs shall be in conduit. Minimum conductor size shall be #12 AWG (4.0 mm2).
B. Type THHN or THWN single conductor with copper conductor for low voltage general use circuits indoor or conditioned areas.
C. Lighting conductors in areas not normally accessible after construction may utilize properly supported type MC cable.
D. Grounding cable shall be Class B or C, Type THWN or THHN insulated and uninsulated soft drawn copper conductors sized as required.

12.7 Cable Connectors and Terminations

A. Power cables shall utilize standard two-hole pressure crimped connectors except when terminating to devices which are provided with clamp type connectors, such as molded case circuit breakers. Hole spacing shall be NEMA standard.
B. Medium voltage shielded cables shall not be spliced. Medium voltage terminations shall have stress relief system applied at the termination of the cables. Stress relief system shall be of the pre-formed cone type, cold shrink type suitable for the cable to which they are to be applied; Manufacturer shall be 3M.
C. Control and Instrument Terminations may utilize Contractor's / Manufacturers' standard.
D. Current Transformer (CT) terminations shall utilize ring lug terminals. Field CT circuits terminating in control and protection cabinets shall be terminated on shorting-type terminal blocks prior to continuation to protective devices.

12.8 12.8 Earthing and Bonding Requirements

A. The BESS earthing system shall be an interconnected network of bare copper conductor, copper-clad ground rods, foundation reinforcing steel, and other grounding electrodes present as defined by the NEC. The BESS facility earthing system shall be connected to any adjacent grounding grids.
B. Contractor shall perform calculations in accordance with IEEE 80 methods to demonstrate the BESS facility is safe from the perspective of touch, step, and transferred potentials. Calculations shall be submitted for Company review.

12.9 Lightning Protection Criteria

A. The requirement for lightning protection shall be evaluated based on a risk-based assessment such as that provided in NFPA 780 Annex L. If required, lightning protection shall be designed and installed in accordance with NFPA 780.
B. Lightning protection equipment shall conform to the requirements of Underwriters Laboratories Standards 96.

12.10 Conduit and Raceway

A. Cable tray design shall be based on the loads to be carried plus the dead weight of the tray system. In addition to, and concurrent with the load specified above, the tray shall be designed to withstand a concentrated load of 200 lbs. (90kg) at the mid-span, at the center of the rung or on either side rail. The safety factor for this load condition shall be at least 1.5 based on the ultimate capacity of the tray or any of its components as determined by test in accordance with NEMA load test VE-1-Sect 4.
B. Cable trays and fittings shall be the standardized products of a single manufacturer designed to permit easy assembly in the field.
C. Aluminum cable trays shall be manufactured of heat-treated ASTM B221 6063 aluminum alloy for extruded parts and ASTM B209 5052 alloy for parts fabricated from sheets. Rungs shall not be movable.
D. Minimum radius for tray bends and fittings shall be eight times the diameter of the largest non-shielded cable or 12 times the diameter of the largest shielded cable to be installed, whichever is the larger. Dropout fittings shall be provided where required to maintain the minimum cable bending radius.
E. In general, trays for cables of different voltage levels shall be stacked in descending order with the higher voltage at the highest elevation. Individual tray systems shall be established for the following services. Trays may be divided into multiple services by the use of continuous, metallic barriers.

1. Medium voltage power cables
2. Low voltage power cables
3. Low voltage control cable
4. Shielded instrumentation cables
5. Communication cables

F. Fire stops shall be provided where trays penetrate exterior walls or fire separation areas.
G. Except for indoor lighting and communications circuits, exposed conduit shall be rigid steel, hot-dipped galvanized.
H. Conduits for lighting, power, and general convenience circuits, and communications circuits in indoor areas may utilize Electrical Metallic Tubing (EMT), hot-dipped galvanized inside and outside. EMT shall not be used in hazardous areas or where subject to physical damage during and after installation.
I. Minimum conduit size shall be 3/4 in (20 mm) nominal diameter except for lighting fixture stems, which may be 1/2 in (16 mm) nominal diameter.
J. Conduits shall be routed such that they do not create a trip hazard.
K. Liquid tight flexible metallic conduit shall be used for connections to accessory devices, for connections to vibrating equipment, and across areas where expansion or movement of the conduit is required. Lengths shall not exceed 3 ft (900 mm).

12.11 Lighting and Wiring Devices

A. The lighting system shall provide personnel with illumination for operation under normal conditions and means of egress under emergency conditions.
B. Interior and exterior luminaries shall be LED type, mounted so they are easily accessible for maintenance to the maximum extent practical.
C. Emergency lighting shall be self-contained emergency lighting units including batteries and battery charger.
D. Lighting levels shall be designed in accordance with the Illuminating Engineering Society (IES) recommendations.
E. Outdoor fixtures shall include photoelectric sensors and motion detectors to keep lights off when not required.
F. Convenience receptacles shall be spaced in the battery storage area such that there is a maximum 100 ft (30.0 m) distance to a receptacle outlet, unless codes require otherwise. An accessible receptacle outlet shall be provided within 25 ft (7.6 m) of each HVAC unit.

12.12 Emergency Stop Switches (E-Stop)

A. Containerized BESS systems shall incorporate an E-stop function into the inverter control panel or local HMI. Containerized BESS system E-stops shall shut down only the affected BESS equipment train.

12.13 Earthing and Bonding Installation and Testing

A. Earthing conductors shall be copper and have a minimum cross-sectional area of #2/0 AWG.
B. Cable trays shall include a bare copper earthed conductor installed the entire length and connected to each section of tray and to station earth grid.
C. Major items of equipment transformers, relay and control panels, and panelboards shall contain copper earthed buses connected to the primary earthing system.
Equipment with multiple sections such as low voltage switchboards shall connect earth bus to station grid at both ends.
D. Each row of battery racks shall be earthed at each end.
E. Metallic structures and equipment housings located on the roof of the building shall be connected to earthing system.
F. The site perimeter fence may be earthed or isolated at Contractor's option, subject to safe touch potential analysis. If the site fence is not earthed, then isolating sections shall be installed where the BESS site fence abuts the existing substation fence.
G. BESS container lightning protection system downcomers shall be terminated to the BESS earthing grid.

H. Earthing system connections shall be made with exothermic welds or nonreversible compression type fittings. Mechanical bolted connections are not permitted.
I. Earthing connections at the substation shall be exothermic weld. Earthing connections on the collection system may be irreversible crimp or exothermic weld.

12.14 Arc Flash Mitigation

A. Contractor shall perform an Arc Flash hazard analysis in accordance with IEEE 1584 for voltages up to 15kV. For voltages above 15kV, Kinectrics ARCPRO software must be utilized.
B. The system shall be designed such that a PPE level of no higher than Level 4 (40 cal/cm2) is required.
C. All electrical equipment shall be labeled in accordance with NFPA 70E. At a minimum, the following information shall be shown on equipment labels:
    1. Nominal system voltage
    2. Arc Flash Boundary
    3. Working distance
    4. Available incident energy at working distance
D. Methods shall be employed to reduce the arc flash hazards including:
    1. Maintenance Mode relay settings and a maintenance mode selector switch (Normal / Maintenance) with blue indicating light for medium voltage switchgear breakers.
    2. Bus differential relay protection.
    3. Transformer differential relay protection on the main power transformer.
    4. Provide remote racking systems for medium voltage draw-out circuit breakers. Remote racking system shall be Safe-T-Rack or Owner approved equal.
    5. Provide actuator to remotely operate pistol grip type breaker Open / Close switches. CBS Arc Safe Chicken Switch or Owner approved equal.

13 PADMOUNTED TRANSFORMERS

13.1.1 General

A. This document specifies the scope of supply and the major design and performance parameters for the Step-Up transformers and the facility station service transformer.
B. Basic design shall be outdoor oil-immersed 3-phase pad mounted distribution transformers designed for daisy-chain or loop feed on the HV side (AS APPLICABLE).

13.2 Applicable Standards

A. Characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of ANSI, IEEE, NEMA, and Department of Energy standards, as applicable.
B. Specifically, but not limited to:
    1. IEEE C57.12.00, and associated applicable parts
    2. C57.12.28
    3. C57.12.34
    4. C57.12.90 for standard testing
    5. C57.12.91
    6. C57.154
    7. NEMA TR1
    8. NEMA 260

13.3 Design Requirements

A. Inverter step-up transformers shall be naturally cooled. Cooling fans shall not be required for continuous operation to achieve maximum rating.
B. Transformers shall be suitable for bi-directional operation.
C. Transformers shall be sized to continuously accept inverter rated kVA output between .9 leading and .9 lagging power factor without overload.

D. Inverter step-up transformers shall be suitable for operation at up to 5% harmonics on both the HV and LV winding at the transformer full load rating.
E. Transformers shall be provided with six high voltage bushings, 600A minimum. HV connections shall be made via elbow disconnects.
F. The Power Conversion System (PCS) step-up transformer voltage ratio shall be selected to match the substation interconnection voltage without use of intermediate step-up transformers.
G. During detailed design, Contractor shall perform an electrical harmonics study to confirm that the proposed PCS system does not cause harmonic resonance when paralleled with the Company's existing equipment. If required, the addition of air core tuning reactors or other mitigating measures shall be engineered and provided by Contractor.

13.4 Testing

A. Perform standard factory tests in accordance with IEEE C57.12.90. Furnish tests reports per submittal requirements.

13.5 Loss Evaluation

A. Transformers will be continuously energized when BESS facility is in standby mode. No-load losses should be minimized to extent practical. Bidders shall include no load and load loss data for BESS transformers. Owner will evaluate the transformer losses using values of $4000/KW for no-load losses and $2000/KW at rated full load output.

13.6 Transformer Data Sheets

Contractor shall submit information in "Vendor Data" column with Proposal.

14 METERING AND PROTECTION

14.1 General

A. This section covers the basic system protection requirements.
B. Contractor shall coordinate with interconnection work to ensure equipment is provided which meets the overall intent of the project and utility interconnection requirements.

14.2 Codes and Standards

A. The design and specification of work shall be in accordance with applicable laws and regulations of the governing bodies, local utility requirements for interconnection, and applicable local codes and ordinances.
B. A listing of the codes and industry standards to be used in design and construction:
   1. American National Standards institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. Institute of Electrical and Electronic Engineers (IEEE)
   4. National Electrical Manufacturers Association (NEMA)
   5. National Fire Protection Association (NFPA)
   6. National Electrical Safety Code (NESC)
   7. Occupational Safety and Health Act (OSHA)
   8. Underwriters Laboratories, Inc. (UL)
   9. National Electrical Code (NEC)

C. Other recognized standards shall be utilized as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards.
D. The Company may be exempt from certain NEC guidelines. The system electrical design shall be NEC compliant to the greatest extent possible and in accordance with all applicable legal requirements.
E. The codes and industry standards used for design, fabrication, and construction shall be the codes and industry standards in effect at the date of this Contract.

14.3 Overall System Protection

A. Contractor shall perform system analysis from the point of interconnection (POI) down to the BESS inverters and station auxiliary LV buses. Where system information is not available, Contractor shall assume an infinite bus at the Substation high voltage bus. Relay settings shall be based on actual system interconnection values which will be provided prior to setting relays.
B. Contractor shall perform initial and final electrical system studies. The scope shall include studies required to design and specify the plant auxiliary electric system within the site boundaries. Studies include, but are not limited to, load flow, feeder and equipment sizing duty calculations, short circuit and protective device coordination, and arc flash.
C. Contractor shall develop relay settings for protection and control devices within Contractor's supply scope. Protection and control settings for the breaker at the POI shall be coordinated with Company's existing protection and control scheme.
   Contractor shall implement settings into relays and test all relays prior to operation.
D. Protective relays shall be solid-state microprocessor type, flush mounted. Protective relays shall be as manufactured by Schweitzer Engineering Laboratories (SEL) or Company approved alternate.
E. Each item of the electrical system shall be provided with a back-up protection that is responsive to electrical faults thus allowing isolation of the faulted item in a timely manner, before major damage is sustained. This is not required to be a separate relay and may form part of the transformer or feeder protection, e.g. over-current and earth fault.
F. Alarm/trouble contacts from each breaker and relay shall be remotely alarmed via SCADA. All protective devices shall be synchronized to the substation same time source via IRIG-B signal.

G. Any devices used to isolate electrical equipment for maintenance shall have a visible airgap or means of visual disconnect.
H. Zig-Zag Grounding Transformers shall be provided as required on each Bus to facilitate ground fault detection. BESS protection shall trip and prevent further operation of BESS if grounding system is unavailable. Grounding transformers shall be automatically removed from service when BESS is not in service and shall be interlocked with turbine generator grounding system and generator circuit breaker to ensure only one grounding system is active at any given time.
    i. KVA Rating as required for effective grounding of AC collection circuits. All grounding transformers to have the same KVA rating, etc. and be interchangeable.
    ii. KVA Rating as required for effective grounding of AC collection circuits. All grounding transformers to have the same KVA rating, etc. and be interchangeable.
    iii. Pedestals for pad mount transformers shall be fiberglass, pre-cast, or poured concrete.
    iv. Grounding transformers shall be sized to keep the collection feeder voltage rise during a fault to less than 1.39pu voltage as per IEEE C62.92.1-2000.

14.4 Metering

Contractor shall provide bi-directional, revenue grade metering at each point of interconnection in the form of a SEL-735 Power Quality and Revenue Meter. Contractor shall also provide provisions for an Company supplied revenue meter (Schneider Electric ION-8500) or Company approved alternate.

BESS facility auxiliary power consumption shall be separately metered, also with an SEL-735 revenue grade meter.

15 LOW VOLTAGE ELECTRICAL DISTRIBUTION

15.1 General

This section covers the low voltage distribution equipment

15.2 15.2 Codes and Standards

A. The design and specification of work shall be in accordance with applicable laws and regulations of the governing bodies, local utility requirements for interconnection, and applicable local codes and ordinances.
B. A listing of the codes and industry standards to be used in design and construction:
    1. American National Standards institute (ANSI)
    2. American Society for Testing and Materials (ASTM)
    3. Institute of Electrical and Electronic Engineers (IEEE)
    4. National Electrical Manufacturers Association (NEMA)
    5. National Fire Protection Association (NFPA)
    6. National Electrical Safety Code (NESC)
    7. National Electrical Code (NEC)
    8. Occupational Safety and Health Act (OSHA)
    9. Underwriters Laboratories, Inc. (UL)
    10. Other Applicable Company Standards
C. Other recognized standards shall be utilized as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards.
D. The codes and industry standards used for design, fabrication, and construction shall be the codes and industry standards in effect at the date of this Contract.
E. The Owner may be exempt from certain NEC requirements. The system electrical design shall be NEC compliant to the greatest extent possible and in accordance with all applicable standards. Deviations from the NEC must be approved by Owner.

15.3 Design Requirements

A. The LV distribution system shall be fed from a dedicated station service transformer. The LV system capacity shall be primarily determined by Contractor's BESS HVAC design. See on-line diagram for additional information.
B. Auxiliary power consumption shall be metered separately.

15.4 15.4 Low Voltage Panelboards

A. Panelboards shall be dead-front, fixed mounted circuit breaker type.
B. Breaker operating handles shall be accessible through a door that can latch and lock. A panel directory shall be placed inside the panelboard door. Circuit breaker assignments shall be consistent with design drawings.

16 MEDIUM/HIGH VOLTAGE EQUIPMENT AND INTERCONNECTION

16.1 General

A. This section covers the scope of work associated with the interconnection of the BESS to the Company's substation. The Contractor shall be responsible for ensuring compliance with the utility and system operator interface requirements.
B. Work shall include Engineering, Procurement, and Construction and shall include:
   1. Site Work
   2. Grounding
   3. Steel Structures
   4. MV and HV Equipment
   5. Metering and Protection
   6. Instrument Transformers
   7. Overhead Lines and Underground Lines
   8. Foundations
   9. Commissioning and Start-up
C. Coordinate ratings and design requirements with interconnection utility. Equipment shall meet at least the minimum requirements. Single-line diagram (s) are provided for reference to show the limits of the anticipated work.
D. The codes and industry standards used for the design, fabrication, and construction shall be the codes and industry standards in effect at the start date of the work.

16.2 Codes and Standards

A. The design and specification of work shall be in accordance with applicable laws and regulations of the governing bodies, local utility requirements for interconnection, and applicable local codes and ordinances.
B. A listing of the codes and industry standards to be used in design and construction:
   1. American National Standards institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. Institute of Electrical and Electronic Engineers (IEEE)
   4. National Electrical Manufacturers Association (NEMA)
   5. National Fire Protection Association (NFPA)
   6. National Electrical Safety Code (NESC)
   7. National Electrical Code (NEC)
   8. Occupational Safety and Health Act (OSHA)
   9. Underwriters Laboratories, Inc. (UL)
   10. Other Applicable Company Standards
C. Other recognized standards shall be utilized as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards.
D. The codes and industry standards used for design, fabrication, and construction shall be the codes and industry standards in effect at the date of this Contract.

E. The Owner may be exempt from certain NEC requirements. The system electrical design shall be NEC compliant to the greatest extent possible and in accordance with all applicable standards. Deviations from the NEC must be approved by Owner.

16.3 Submittals

A. Provide submittals in accordance with project submittal requirements.
B. Preliminary and detail design engineering and construction documents, to include:
   1. Nameplate data.
   2. Schematic design drawings for Company review.
   3. Detailed construction drawings for Company review.
   4. Protection coordination study, selectivity, and settings.
   5. Final sealed and signed conform to construction record drawings at the completion of the project.
   6. Test Reports
   7. Operation and Maintenance Manuals.
C. Relay protection shall include such things as the study report, time coordination curves, settings, setting manuals, setting files for downloading into relays, and programming of protection devices.
D. Documentation for each relay, meter, or programmable controller furnished or altered under this contract shall include supporting calculations and/or methodology for each setting that differs from the relay vendor's factory default settings. In addition, a logic drawing shall be provided that clearly documents all custom logic and the logic driving all relay output. Relay output includes; contact outputs, virtual outputs, LED targets, and LCD display message.

16.4 Site Work

A. Excavate as required for new breaker and takeoff structure foundations.
B. After completion of foundations, structures, ground grid; underground duct bank/precast cable trench and conduits, and other permanently installed equipment, the areas shall be backfilled and compacted to 95% modified proctor to an elevation of 6 in below finished grade.
C. All areas within the substation shall be finished with 6 in of cleaned, crushed rock to match existing substation surfacing. The rock must have a minimum of 3 fractured faces and must meet the minimum requirements for appropriate step/touch potentials.

16.5 Grounding

A. All new above grade structures shall be connected to the substation grounding grid with #4/0 AWG bare copper conductors.
B. Manual disconnect switch operators shall have a potential equalizing (switching) mat installed. Switching mats shall be constructed from galvanized 4 ft x 6 ft metal grating set level on top of the stone yard surface and connected to the ground grid and to the switch handle / operator ground.

16.6 Circuit Breakers (APPLICABLEFORHVINTERCONNECTIONS)

A. Provide three phase, freestanding, SF6 dead tank breaker, complete.
B. Install breakers on new concrete foundation.
C. Equip breakers with the number of multi-ratio current transformers (MRCT) required for use in protective relaying or metering.

16.7 Islanding Switchgear (APPLICABLE FOR MV INTERCONNECTIONS)

A. Provide three phase, freestanding, metal clad switchgear lineup
B. Switchgear shall be outdoor, arc rated construction
C. Switchgear shall include vacuum circuit breakers, instrument transformers, and protective relaying

16.8 Instrument Transformers

A. Current and voltage transformers are required for protection and metering. High accuracy CTs shall be required for revenue metering.

B. Current and voltage transformers shall meet the utility interconnection requirements for both type and accuracy class. Accuracy class shall be maintained for any tap position on a multi-ratio CT, specifically for metering applications during lightly loaded conditions.
C. Protection and metering CTs should be separate.

16.9 Underground Raceway

A. All underground circuits installed in the substation shall be encased in conduit, ductbank, or a cable trench.
B. Duct banks shall be concrete encased. Cable trench shall have covers rated for the appropriate loads that may be encountered.
C. The AC collection circuits from the BESS to the substation may be direct buried after exiting the substation.

16.10 Foundations

A. Foundations shall be provided as specified in other Sections of this specification.
B. Substation foundations shall extend at least 12 in (300 mm) above finished grade.

17 BATTERIES, RACKS, AND BMS

17.1 General

A. This section establishes the minimum functional specifications for the Batteries, Racks, and Battery Management System (BMS).
B. The system supplied under these specifications is a pilot project and will be used by the Company to test various operating modes / use cases as described more fully in Section 20.0, Site Controller.

17.2 Batteries

A. Battery cell/module design shall be of proven technology and shall have been installed in similar applications for a minimum of one year. It is expected that battery cells/modules are sourced from recognized “Tier 1” manufacturers. It is expected that replacement modules of the same design or of a directly compatible design will be readily available from the manufacturer for a minimum of 10 years such that rack modifications are not required.
B. Battery racks shall be factory pre-assembled into vertical sections. Rack dimensions shall be manufacturer’s standard, designed for installation into a building or environmental enclosure arranged in back-to-back rows. Racks shall include all bracing required for the site seismic conditions and to ensure racks cannot tip during module installation. Racks shall be suitable for installation directly onto a finished concrete floor with tolerances specified in other sections of this specification. Racks shall be anchored using drilled concrete anchors and leveling shims as required. Rack design shall include provisions to protect personnel from inadvertent contact with exposed energized parts, such as ventilated doors or insulated covers over live parts

Table 12 Minimum Battery Functional Specifications

Table 1- Minimum Battery Functional Specifications	
Description	**Requirements**
Intended use	Utility-scale battery energy storage system
Applications / Use Cases	This application is C/2 = 0.5 C Primary application is energy time-shift and arbitrage (C = 0.25) Secondary application is intermittent generation smoothing and ramp rate control. (C = 0.5) Additional use cases include Automatic Voltage Regulation and Autonomous Frequency Regulation. (C = 0.5) The battery will be operated at Charge/Discharge rates ranging from 2 hours to 4 hours by varying the power flow through the inverters. Maximum C rate is 0.5. (C-rate is a measure of the rate at which a battery is discharged relative to its maximum capacity. The c rate is calculated as the inverse of battery discharge rate in hours. i.e. a battery that discharges in 2 hours would have a C rate of ½ = 0.5.)
Beginning of Life Power	500 kW
Beginning of Life Energy	1,000 kWh useable depth of discharge (DOD) @ 0.5C
Minimum End of Life Energy	EPC to provide expected degradation curves based on specified Duty Cycle with proposal.
Duty Cycle	200 cycles of full depth of charge/discharge per year at 0.25C, plus 10 cycles per day within +/- 15 percent range DOD (of 50% nominal SOC) at 0.5C
Charging Method	Constant Current / Constant Voltage
Discharging Method	Constant Current
Design Life	Component life 20 years.
Warranty requirements	Manufacturer Standard
Design Ambient (battery enclosure)	23C +/- 5C
Design Humidity (battery enclosure)	20 – 100%, non-condensing
Seismic Data	Refer to Section 2.4

17.3 Racks

A. Each rack section (or pair of sections for long duration systems) shall include a load break disconnecting means to allow isolation of the rack's modules from the DC bus by the Battery Management System.

17.4 Battery Management System

A. The Battery Management System (BMS) shall be the battery OEM's standard product, providing the following functions at a minimum:
   1. Measurement of Battery operating parameters
   2. Measurement of battery cell voltages
   3. Measurement of battery cell temperatures
   4. Measurement of battery string current
   5. Measurement of battery string voltage
   6. Calculation of battery string State of Charge (SOC)
   7. Calculation of battery string State of Health (SOH).
   8. Cell Balancing
   9. Battery Protection from the following:
      a. Cell under voltage
      b. Cell over temperature
      c. Cell under temperature
      d. Cell over current
   10. Pre-charge protection

B. At a minimum, the BMS shall monitor the data points listed in Table 2. The BMS shall monitor all data points required and store data a minimum of 24 hours of pre and post-event (or as required by the battery OEM) for root cause / post mortem analysis and warranty claim disposition. Data points shall also be transmitted to the Site Controller / Historian for long term data storage and retrieval.

C. Rack BMS to System BMS communication protocol shall be manufacturer standard.

D. System BMS to Site Controller communication protocol shall be Modbus TCP/IP or alternate as approved by Purchaser.

Table 13 Minimum BMS Functional Specifications

Table 2- Minimum BMS Functional Specifications	
Description	**Points to be Monitored.** *Sample interval 1 second.*
System Level	Fault Status
	Alarm Status
	System Current
	System Voltage
Each Rack or String	Rack Voltage
	Rack Current
	Rack SOC
	Rack SOH
	Rack Fault Status
	Rack Alarm Status
	Maximum Cell Voltage Value
	Maximum Cell Voltage Position
	Minimum Cell Voltage Value
	Minimum Cell Voltage Position
	Maximum Cell Temperature Value
	Maximum Cell Temperature Position

Table 2- Minimum BMS Functional Specifications	
	Minimum Cell Temperature Value
	Minimum Cell Temperature Position
	Rack DC Switch Status

18 POWER CONVERSION SYSTEM

18.1 General

A. This section establishes the minimum functional specifications for the BESS Power Conversion Systems (PCS).
B. The PCS, in conjunction with the BESS Site Controller, shall be capable of automatic, unattended operation. The PCS shall include all necessary self-protective and self diagnostic features to protect itself from damage in the event of component failure or from operating beyond equipment ratings, whether due to internal or external causes.
C. The PCS system shall include provisions for isolation on both the AC and DC terminals. Disconnecting provisions shall be capable of being locked out to facilitate Company's LOTO process for maintenance work. Filter capacitors shall be provided with bleeder resistors or other means of discharging to less than 50 volts within approximately one minute of de-energization.

18.2 Codes and Standards

A. UL 1741
B. IEEE 1547
C. IEEE 519
D. Other Applicable Company Standards

18.3 Inverters

A. The inverters supplied under these specifications will be used by the Company to test various BESS operating modes as part of a pilot project. Operating in conjunction with the Site Controller, the PCS shall be able to operate in all modes specified in Section 20.0.
B. Inverters shall be of proven technology and shall have been installed in similar applications for a minimum of one year. The PCS must be sourced from recognized "Tier 1" manufacturers such as those provided in the approved supplier list.
C. Inverters shall have a design life of not less than 20 years and shall be suitable for installation in an outdoor environment. It is expected that replacement components will be readily available from the manufacturer for the design lifetime.

18.4 PCS Specifications

A. The PCS internal cooling system design may be the manufacturer's standard, provided that failure of a single cooling fan does not cause more than 50% derating of the affected PCS's power rating.
B. The PCS transformer shall meet the requirements of Section 13.0- Pad Mounted Transformers.
C. The PCS shall meet the requirements of the following:

Table 14 Minimum PCS Functional Specifications

Table 3- Minimum PCS Functional Specifications	
Description	**Requirements**
Intended use	Utility Scale Grid Interactive Storage System Pilot

Table 3- Minimum PCS Functional Specifications	
Description	**Requirements**
Applications / Use Cases	Primary application is energy time-shift and arbitrage (C = 0.25) Secondary application is intermittent generation smoothing and ramp rate control. (C = 0.5) Additional use cases include Automatic Voltage Regulation and Autonomous Frequency Regulation. (C = 0.5) The battery will be operated at Charge/Discharge rates ranging from 2 hours to 4 hours by varying the power flow through the inverters. Maximum C rate is 0.5.
Project Power Rating	500 kW across power factor range of .95 lagging to .95 leading without active power de-rating
Reactive Capability	Inverters shall be capable of operation between 0.8 lagging to 0.8 leading power factor with active power de-rating
Inverter Form Factor	Central or distributed (rack / string) are acceptable.
Charging Method	Constant Current / Constant Voltage
Discharging Method	Constant Current
Design Life	Component life 20 years.
Inverter Nominal Voltage Range, DC	To be coordinated with Company-furnished battery
Inverter Nominal Voltage, AC	As selected by EPC
Warranty requirements	Manufacturer Standard
Installation	Outdoors, 20 feet altitude
Design Ambient	See Section 2.0.
Design Humidity	See Section 2.0.
Seismic Data	See Section 2.0.

19 BI DIRECTIONAL INVERTERS/ DC-DC CONVERTERS

19.1 General

A. Operating in conjunction with the Site Controller, the PCS shall be able to operate in all modes specified in Section 20.0.
B. Inverters/converters shall be of proven technology and shall have been installed in similar applications for a minimum of one year. It is expected that PCS are sourced from recognized manufacturers as listed in Attachment D.
C. Inverters/converters shall have a design life of not less than 20 years and shall be suitable for installation in an outdoor environment. It is expected that replacement components will be readily available from the manufacturer for the design lifetime.

20 SITE CONTROLLER

20.1 General

A. This section establishes the minimum functional specifications for the BESS Site Controller.
B. The BESS system supplied under these specifications will be used by the Company to test various operating modes as part of a pilot project. The Site Controller shall coordinate with the PCS and BMS to perform the functions specified in this section.
C. The Site Controller shall interface with the Company's remote dispatch system. Contractor may coordinate revisions to the Company's existing SCADA remote interface gateway or may furnish a new gateway. The remote interface gateway shall be a SEL RTAC 3530 or equal. Communication with Company's remote dispatch system shall utilize DNP3 Ethernet protocol.
D. The Site Controller shall aggregate the operation of the individual Power Conversion Systems such that the BESS may be remotely operated as if a single asset. The Site Controller shall include a data historian function able to store a minimum of 1 month of required BESS operating data locally. The Site Controller shall include a local HMI station and shall be located in a separate control enclosure. .
E. The Site Controller hardware and application software shall be of proven technology and shall have been installed in similar applications for a minimum of one year.

20.2 Operating Modes

A. At a minimum, the Site Controller shall provide the following BESS operating modes:
   1. **Direct Remote Control (Modular Energy System Architecture (MESA) function 9)**. In the Direct Remote Control mode, the BESS responds directly to signals from a remote dispatch system in the same way a conventional dispatchable generation asset is controlled. Because a BESS is a bidirectional generation asset, the remote dispatch system must provide a real-time "signed" dispatch signal commanding the BESS to charge (negative value), discharge (positive value), or remain idle (0) as necessary. The rate of charge/discharge is determined by the magnitude of the dispatch signal.
      Both the real power output (MW) and reactive power output (controllable as power factor) may be adjusted; operating at power factors less than unity reduce the BESS MW output rating to maintain inverter MVA within its rating.
      In this mode, the BESS relies upon the remote system to determine the optimum operating mode of the BESS in consideration of real time price signals, battery state-of-charge, and any upcoming scheduled operating modes having higher priority.

   2. **Scheduled Charge/Discharge Mode (MESA function 23**) -- Charging and discharging direction and magnitude is controlled according to a fixed time schedule. The local site controller shall store at least 20 user-defined schedules, any of which may be selected locally or via SCADA command. For each schedule, the user shall have the ability to set the time of day at which the charge or discharge is to begin and desired charge or discharge rate vs. time.

   3. **Frequency Bias (droop) Mode (MESA function 18)** -- The local site controller shall contain a droop control function with adjustable proportional gain (droop) and dead band settings. When Frequency Bias is enabled, the present charge or discharge setting is biased by an amount proportional to measured system frequency. For example, with the droop controller set at 5%, a 5% drop in system frequency (3 Hz) would cause a control bias of 100% of discharge rating (20 MW), assuming the battery is at a sufficient state-of-charge. Frequency fluctuations within an adjustable dead band range shall have no effect. The Frequency Bias mode can be enabled or disabled, and when enabled shall operate concurrently with any other active control mode.

   4. **Frequency Response Mode (MESA function 8)** --(need to discuss whether the battery will be controlled directly by the remote dispatch system for this mode or operate autonomously. If autonomously, the Frequency Bias mode above would provide the same functionality. Another possibility is to add a feature such that the amount of

power and/or energy that the BESS provides autonomously to support system frequency is limited (for example, limit MW to xx% of rating, or limit the amount of discharged energy to xx% DOD.
The benefit to being dispatched vs. operating autonomously is that Xcel could receive revenue under a market structure similar to PJM Reg D if dispatched whereas autonomous operation might be difficult to meter and be compensated for.)

5. **Power Smoothing mode (MESA function 16)** --This function is intended to decrease the rate of change and smooth the output of intermittent generation resources. The BESS charges or discharges in proportion to the error between the moving average generation and the instantaneous generation at the POI, subject to an adjustable deadband. The degree of response (gain) is Operator adjustable to allow matching the amount of smoothing possible given the relative capacity of the battery based upon its real time state of charge vs. the variation in intermittent generation.

6. **Ramp Rate Limiter mode (similar to MESA function 16)** – The BESS is used to limit the rate of change of generation output from intermittent generation resources. The BESS is operated at a selected nominal state of charge, such that it can be charged to limit the "ramp up" and discharged to limit "ramp down" rate of change in intermittent generation respectively. The intermittent generation ramp rate is continuously calculated by comparing the current intermittent generation against the previous 1-minute average generation. If the intermittent generation ramp rate exceeds the setpoint value, the controller commands the BESS to charge or discharge only as required to limit the up or down ramp to the setpoint value. No action is taken for intermittent generation ramp rates less than the setpoint value.

7. **Automatic Voltage Regulation (AVR) (MESA function 20**)- The BESS operates autonomously to maintain the substation bus voltage at setpoint by adjusting the BESS power factor setting. Setpoint voltage and high/low voltage dead band range are adjustable. The Voltage Regulation mode does not have a direct control on the BESS MW setting and may be operated simultaneously with other control modes. When the local AVR mode is disabled, the BESS active and reactive power output are separately controllable via SCADA dispatch commands within the BESS's MVA rating (Direct Remote Control function 9).

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20.3 SCADA Interface

20.3.1 Remote Control Interface

The BESS control system mode selection shall be possible locally via the site controller HMI or via the remote SCADA system.
The Site Controller shall locally store the data points listed in Section 17.0, **Table 2** at a collection interval of once per second.
The Site Controller shall aggregate the rack / string level data listed in **Table 2** and transmit to the remote dispatch system via SCADA RTAC at a two second intervals.
The SCADA interface must be fully capable of communicating with all required Company energy management systems.
(Table of required SCADA control points and data points to be transmitted from/to remote dispatch will be added here.).

21 TELECOMMUNICATIONS AND NETWORK

21.1 General

A. Contractor's scope includes design, equipment, and installation of a complete local area network to allow monitoring of the BESS facility from a remote location.

B. System and subsystems provided by Contractor shall be designed and configured for unmanned operation of the facility.
C. communication connections to the remote System Operator shall connect serially via DNP 3.0 or Modbus TCP to the switchgear SEL-3530 (RTAC).
D. Network media internal to equipment enclosures may be implemented via CAT 6 cables.
E. Terminations to equipment shall be made using pre-fabricated patch cables. CAT 6 cables exiting equipment shall first terminate on a patch panel.
F. Fiber installed underground on the premises shall be installed in conduit. Bends and risers extending above ground shall be metallic conduit.
G. Fiber installed in buildings or enclosures may be routed in inner-duct supported in instrument and control trays.
H. Network communications leaving the project site shall be implemented using fiber optic cable installed in HDPE or similar underground conduit following regional practices for telecommunications installations.

22 SUBMITTALS

22.1 General

A. This section defines the requirements for engineering design and vendor submittals.
B. Submittals shall be in English.
C. Contractor has sole responsibility to meet completion date requirements and to supply material and equipment that conforms to Contract. Company's review does not constitute a waiver of Company rights with respect to nonconforming Work.
D. Contractor shall furnish expected document submittal list and schedule to Company within 60 days of award.
E. All design documents must use Company drawing templates & follow all Company drawing standards.

22.2 Specifications

22.2.1 Efficiency

Table 15 Efficiency

Specification Parameter	Description	Units	Value
System Round Trip Efficiency	Total round trip efficiency from beginning of life (BOL) to end of life (EOL), defined as the ratio of the delivered output energy of the energy storage system to the absorbed input energy required to restore it to the initial state of charge under specified conditions.		
	Provide the total round-trip efficiency under the following conditions, at the beginning of life (BOL).		
	100% DoD Cycles, @ 50% SOC, Full rated power.	%	
	100% DoD Cycles, @ 50% SOC, Half rated power.	%	
	100% DoD Cycles, @ 50% SOC, Quarter rated power.	%	
	20% DoD Cycles, @ 50% SOC, Full rated power.	%	
	20% DoD Cycles, @ 50% SOC, Half rated power.	%	
	20% DoD Cycles, @ 50% SOC, Quarter rated power.	%	
	___% DoD Cycles, @ __% SOC, Full rated power.	%	
	___% DoD Cycles, @ __% SOC, Half rated power.	%	

Specification Parameter	Description	Units	Value
	___% DoD Cycles, @ __% SOC, Quarter rated power.	%	
	Provide the total round-trip efficiency under the following conditions, at the end of life (EOL).		
	100% DoD Cycles, @ 50% SOC, Full rated power.	%	
	100% DoD Cycles, @ 50% SOC, Half rated power.	%	
	100% DoD Cycles, @ 50% SOC, Quarter rated power.	%	
	20% DoD Cycles, @ 50% SOC, Full rated power.	%	
	20% DoD Cycles, @ 50% SOC, Half rated power.	%	
	20% DoD Cycles, @ 50% SOC, Quarter rated power.	%	
	___% DoD Cycles, @ __% SOC, Full rated power.	%	
	___% DoD Cycles, @ __% SOC, Half rated power.	%	
	___% DoD Cycles, @ __% SOC, Quarter rated power.	%	

22.2.2 Dimensions and Physical Characteristics

The focus of this section is to specify the total land use and equipment footprints and weight of the ESS project.

Table 16 Dimension and Physical Characteristics

Specification Parameter	Description	Units	Value
Total Land Use Requirement	Length x Width (LxW) including all keep-away and access areas, including ESS, control room, auxiliary equipment, any special access and space requirements for construction, etc.	m^2	Provided by supplier
Equipment Footprint	Length x Width (LxW) of equipment only (Includes ESS and all ancillary units as required) in intended layout.	m^2	Provided by supplier
Height	Equipment height plus safe clearance distances above the equipment.	m	Provided by supplier
Weight	Weight per individual sub-system (PCS, ESS, accessories, etc.), including maximum shipping weight of largest item that will be transported to the project site.	kg	Provided by supplier
Maximum Equipment Structural Loading	Maximum weight per loaded area for any one piece of equipment.	kg	Provided by supplier

22.2.3 Environmental Operating Conditions

This section includes the requirements that affect the environmental operating conditions of the vendor's total system or the project's needs.

Table 17 Environmental Operating Conditions

Specification Parameter	Description	Units	Value
System Minimal Operational Temperature	Minimal temperature at which the system can operate at its rated capacity (also consider min/max temp limits when in standby or when idle).	°C	Provided by supplier
System Maximum Operational Temperature	Maximum temperature at which the system can operate at its rated capacity (also consider min/max temp limits when in standby or when idle).	°C	Provided by supplier
System Maximum Operational Altitude	Maximum altitude at which the system can operate at its rated capacity (also consider min/max temp limits when in standby or when idle).	m	Provided by supplier
Indoor Installation	ESS is intended to be installed in a protected indoor environment.		Provided by supplier
Mechanical Stress - Outdoor - Water Proof (Against Rain, Snow, and Ice)	ESS is intended to be installed in an outdoor environment and is protected against average levels of environmental stress (e.g. NEMA 3R rated protection).		Provided by supplier
Mechanical Stress - Outdoor - Rated for Mild Coastal Environments	ESS is intended to be installed in an outdoor environment and is protected against average levels of environmental stress (e.g. NEMA 3R rated protection).		Provided by supplier
Mechanical Stress Outdoor - Rated for Extreme Coastal Environments	ESS is intended to be installed in an outdoor environment and is protected against average levels of environmental stress (e.g. NEMA 3R rated protection).		Provided by supplier
Mechanical Stress - Outdoor - Expected Period between Major Exterior Refinishing	Estimated time before exterior refinishing when operated in the intended customer application.	yr	Provided by supplier
Mechanical Stress - Outdoor - Wind Speed Limit	Rated wind speed before damage to the ESS occurs.	m/s	Provided by supplier
Mechanical Stress - Outdoor - Flood Tolerant (Height)	Rated flood tolerance height.	m	Provided by supplier
Mechanical Stress - Indoor/Outdoor - Seismic Zone	Rated earthquake withstand capability.	zone	Provided by supplier
Mechanical Stress - Outdoor - Other	Other known outdoor mechanical stresses to consider for the project site.		Provided by supplier
System Operational Altitude Range	Rated maximum altitude at which the ESS can perform according to its full specifications.	m	Provided by supplier
Range of Operational Humidity Range (%RH)	Range of humidity in which the ESS can operate according to its full specifications.	%RH	Provided by supplier
Storage Humidity Range	During construction phase and spare part storage requirements.	%RH	Provided by supplier
Electrical Stress - Surge Protection (Incoming Lines)	Incoming lines are protected from electrical surges and applicable standard.		Provided by supplier
Electrical Stress - Grounding Points on Exterior Chassis	Number and positions of grounding points on the exterior chassis.		Provided by supplier
Electrostatic Discharge (ESD) Certification and Testing	The system is impervious to ESD events and to what standard.		Provided by supplier

Specification Parameter	Description	Units	Value
Communication Line Surge Certification and Testing	The communication lines are protected from electrical surges and tested to the listed standards.		Provided by supplier
EMI (Electromagnetic Interference) and Immunity	Standards to which the ESS is compliant.		Provided by supplier
Electromagnetic Immunity	Standards to which the ESS is compliant.		Provided by supplier
Unintentional Electromagnetic Radiation	Standards to which the ESS is compliant.		Provided by supplier

22.2.4 Emissions & Environmental Impact

This section includes the specifications of the vendor's total system emissions and/or environmental impact or the project's requirements for these parameters.

Table 18 Emissions & Environmental Impact

Specification Parameter	Description	Units	Value
Sound Emissions - 2m High, 1 m from Perimeter	Audible Noise dB at 1 m distance.	dB	Provided by supplier
Sound Emissions - 2m High, 3 m from Perimeter	Audible Noise dB at 3 m distance.	dB	Provided by supplier
Fluids Containment Necessary (Moat, Tank, or Pond)	Type, amount, and under which conditions.		Provided by supplier
PM – (Airborne) Particulate Matter	Type, amount of emitted airborne particulates and under which conditions with respect to the energy through-put.	MT/MWh	Provided by supplier
Gas Emissions (NO_x or SO_x or CO_2)	Type, amount of emitted gas, and under which conditions with respect to the energy through-put.	MT/MWh	Provided by supplier
Other Environmental Hazards or Concerns	Protection measures against insects, rodents, snakes, and other creatures that could cause damage to the ESS.		Provided by supplier
Third-Party Transportation Certifications	UN 38.3 compliant and certified energy storage components.		Provided by supplier
EU Safety Certifications	The Battery Directive (EU)		Provided by supplier
EU Regulated Hazardous Materials Certifications	RoHS (EU)		Provided by supplier
China Regulated Hazardous Materials	RoHS (China)		Provided by supplier
European Regulated Recyclable Materials Certifications	REACH – Europe		Provided by supplier

22.2.5 Energy Capability

Table 19 Energy Capability

Specification Parameter	Description	Units	Value
Rated Discharge Energy	The accessible energy that can be provided by the ESS at its AC terminals when discharged at its beginning of life (BOL) and end of life (EOL).	kWh	1,000

22.2.6 Recharge Characteristics

Table 20 Recharge Characteristics

Specification Parameter	Description	Units	Value
Minimum Charge Time	The minimum amount of time required for the ESS to be charged from minimum SOC to its rated maximum SOC.	h	Provided by supplier
Recommended Charge Power	Recommended charge power while staying within the manufacturer's rated guidelines on SOC and internal temperatures.	kW	Provided by supplier
Typical Recharge Time	This should include any time for rest a period needed between a full or partial charge or discharge cycle.	h	Provided by supplier

22.2.7 Cycle Life

Table 21 Cycle Life

Specification Parameter	Description	Units	Value
Cycle Life	The numbers of cycles that the energy storage system can perform until end-of-life (EOL), independent of calendar life degradation, at specified depth of discharge after which electricity storage becomes inoperable or unusable for a given application.		Provided by supplier
	Specify cycle life at full-rated power.	Qty.	Provided by supplier
	Specify cycle life at half-rated power.	Qty..	Provided by supplier
	Specify cycle life at quarter-rated power.	Qty.	Provided by supplier
End of Life Criteria	The condition of the ESS at the end of life in terms of capacity, impedance, efficiency, and other pertinent parameters.	Charts	Provided by supplier
Cycle Life Under Customer Application Load Profile	Chart of the degradation rate of capacity and impedance (if applicable) with respect to a measurable duty in the customer application (such as watt-hour through-put or cycles). Specify Charge/Discharge, DoD, and EOL conditions.	Charts	Provided by supplier

22.2.8 Self-Discharge

Table 22 Self-Discharge

Specification Parameter	Description	Units	Value
Self-Discharge Rate	Rate at which the ESS will lose SOC.	kWh/month	Provided by supplier
	Self-discharge at with System OFF while being held at 100% SOC.	kWh/month	Provided by supplier
	Self-discharge at with System OFF while being held at 50% SOC.	kWh/month	Provided by supplier
	Self-discharge with System ON while being held at 100% SOC.	kWh/month	Provided by supplier
	Self-discharge with System ON while being held at 50% SOC.	kWh/month	Provided by supplier

Balance of System

These specifications are related to any equipment outside of the primary energy storage technology that may require auxiliary power and communications from the grid.

22.2.9 Auxiliary Power System & Components

Table 23 Auxiliary Power System & Components

Specification Parameter	Description	Units	Value
Auxiliary Power Components Required	The type of auxiliary power components required for the ESS if applicable. May include the power required for cooling fans, oil pumps, and other ancillary equipment that is needed for the functioning of the ESS to charge or discharge ESS.		Provided by supplier
Total Auxiliary Power Required	Specify by each auxiliary power component.	kW	Provided by supplier
Average Auxiliary Power Required - Continuous	Aux continuous power (used to estimate system tare losses and to size the continuous rating of a power transformer or other thermally tolerant devices).	kW	Provided by supplier
Total Auxiliary Power Required - Peak Power (Locked Rotor, etc.)	Aux peak power (locked rotor, etc.) used to size the ratings of in-line fuses and wiring and other thermally intolerant assets).	kW	Provided by supplier
Aux Nominal Voltage	Specify	Vac	Provided by supplier
Auxiliary VAC Wiring	Auxiliary number of phases (1, 2, or 3).	No of Phases	Provided by supplier
Aux Circuit Breaker Rating	Recommended breaker rating for auxiliary power circuits.	A	Provided by supplier

22.2.10 Thermal Management

Table 24 Thermal Management

Specification Parameter	Description	Units	Value
Type (HVAC, Chiller, Blower, etc.)	Thermal management systems that are used to heat or cool the ESS (if applicable).		Provided by supplier
Liquid Type Required (if Any)	Liquid used to transport heat from one part of the system to another (if applicable).		Provided by supplier
Expected 100% Capacity Availability of Thermal System	Amount of heat (watts) the thermal system can remove (or add) from (to) the ESS when the thermal system is operating at 100% capacity.	W	Provided by supplier
Redundancy	Redundancy built into the cooling system (if any). Percentage of ESS that will shut down if all or part of the cooling system were to fail or shut down for maintenance. Length of time the ESS can operate under partial capability conditions and specify conditions.	%, hr	Provided by supplier

22.2.11 Communications, Control, Monitoring

Table 25 Communications, Control, Monitoring

Specification Parameter	Description	Units	Value
Grid Communication Protocols/Standards	List of codes/standards with which the ESS is compliant.		Provided by supplier
Inverter Communication Protocols/Standards	List of codes/standards with which the ESS is compliant.		Provided by supplier
Cybersecurity Standards & Compliance	List of codes/standards with which the ESS is compliant.		Provided by supplier
Component Communication Protocols/Standards	List of codes/standards with which the ESS is compliant.		Provided by supplier
Communication Protocols (to External Host)	Communication protocols, if available, used to control and interact remotely with the ESS.		Provided by supplier

22.2.12 Cybersecurity

Table 26 Cybersecurity

Specification Parameter	Description	Units	Value
Security Measures (Encryption, Passwords, Physical)	Specify additional details on physical and cyber security.		Provided by supplier

22.2.13 MV Transformer

If required by the project, this section includes specifications for medium voltage transformer equipment.

Table 27 MV Transformer

Specification Parameter	Description	Units	Value
Medium Voltage Transformer Included	Step-up transformer to connect to a MV or HV grid point of interconnection.		Provided by supplier
Medium Voltage Transformer Type (if applicable)	Specify		Provided by supplier
Transformer kVA Rating	The continuous power rating of the transformer.	kVA	Provided by supplier
Transformer Temperature Rating (Rise)	Specify	°C	Provided by supplier
Transformer Impedance	(Short circuit) at rated temperature.	Ohms	Provided by supplier
Transformer Impulse Levels - HV Winding(s) BIL	Specify	kV	Provided by supplier
Transformer Impulse Levels - LV Winding(s) BIL	Specify	kV	Provided by supplier
Transformer Taps	Configurable taps on either winding to adjust the voltage ratio.		Provided by supplier

22.2.14 MV Switchgear

If required by the project, this section includes specifications for medium voltage switchgear equipment.

Table 28 MV Switchgear

Specification Parameter	Description	Units	Value
MV Protection Components?	Specify		Provided by supplier

Specification Parameter	Description	Units	Value
Relay Protection	Medium voltage protection components, such as relays, breakers, meters, PT/CTs, etc.		Provided by supplier
Breaker Type	Specify		Provided by supplier
PCC Meter	A meter is provided for monitoring power and grid conditions at the point of common coupling.		Provided by supplier
PCC Meter Type and Accuracy	PCC meter accuracy class and type (if applicable).		Provided by supplier
PT/CTs at PCC	PTs and CTs are included in the ESS installation for the PCC meters.		Provided by supplier
PT/CTs Accuracy Type and Accuracy Class	PT/CTs type and accuracy class (if applicable).		Provided by supplier
Other Protection and Safety Component	Other protection and safety components.		Provided by supplier

22.2.15 Safety/Protection

If required by the project, this section includes specifications for safety and protection equipment.

Table 29 Safety/Protection

Specification Parameter	Description	Units	Value
Self Protecting Components ES against User Error	Self protection of a subsystem in a situation where a user commands the system to do something it was not intended to do.		Provided by supplier
Self Protecting Components ES against Internal Fault	Self protection of a subsystem in a situation where an internal fault occurs (including faults of other subsystems).		Provided by supplier
Self Protecting Components PCS against User Error	Self protection of the power conversion subsystem in a situation where a user commands the system to do something it was not intended to do.		Provided by supplier
Self Protecting Components PCS against Internal Fault	Self protection of the power conversion subsystem in a situation where an internal fault occurs (including faults of other subsystems).		Provided by supplier
Self Protecting Components Thermal Management against User Error	Self protection of the thermal management subsystem in a situation where a user commands the system to do something it was not intended to do. Excessive wear and tear is not considered "damage" in this context.		Provided by supplier
Self Protecting Components Thermal Management against Internal Fault	Self protection of the thermal management subsystem in a situation where an internal fault occurs (including faults of other subsystems)? Provide an FMEA.		Provided by supplier
Fire Suppression in Energy Storage Units	Extinguishing material(s) and deployment system used at site to suppress fire.		Provided by

Specification Parameter	Description	Units	Value
			supplier
Fire Detection in Energy Storage Units	Type, location, and communications systems.		Provided by supplier
Fire Suppression in Power Conversion Units	Type, location, and communications systems.		Provided by supplier
Fire Detection in Power Conversion Units	Type, location, and communications systems.		Provided by supplier
Toxicity of Fire Suppressant	Materials safety data sheet (MSDS).		Provided by supplier
Ground Fault Detection	ESS detects the presence of an un-intended connection to ground of one of its power lines (either DC or AC).		Provided by supplier
Ground Fault Detection Response	Response of the system after a ground fault indication.		Provided by supplier
Ground Fault Detection Response Time	Length of time to detect a ground fault and respond		Provided by supplier
OSHA Compliant Service Spaces	Service areas in which a human needs to work compliant to OSHA Safety guidelines.		Provided by supplier
NESC/NEC/NFPA Compliant Service Spaces	Service areas in which a human needs to work compliant to the applicable electric safety guidelines such as NESC or NEC or equivalent.		Provided by supplier
Safety Signage	Safety signs warning of high voltage and/or chemical hazards within the ESS perimeter.		Provided by supplier
Emergency Lighting in Service Spaces	Service areas lit by emergency lighting for safe egress in the case of an auxiliary power outage.		Provided by supplier
Lockable Disconnects between Major System Components	Power connections between major system components (such as between the ESS and the PCS), separable by a disconnect switch which can be locked in the open position.		Provided by supplier
Emergency Stop or EPO Switches	Prominently positioned, easily accessed switches that can render the system inoperable (with the aim of stopping an un-safe condition from causing continued damage).		Provided by supplier
Emergency Egress in Service Spaces	More than one exit from service areas which contain high voltage and/or significantly flammable materials.		Provided by supplier
Internal Beacon/Siren for Emergency Condition Annunciation	Emergency beacons, auditory and/or visual, inside the service areas to warn technicians inside those areas of dangerous conditions.		Provided by supplier
External Beacon/Siren for Emergency	Emergency beacons, auditory and/or visual, outside the service areas to warn technicians outside those areas of dangerous conditions.		Provided by supplier

Specification Parameter	Description	Units	Value
Condition Annunciation			
Remote Signaling for Emergency Condition Annunciation	Provisions for remote signaling to remotely positioned terminals or systems of faults within the ESS.		Provided by supplier
SDS Information	Safety Datasheets (SDS) available on-site, in an easily accessible location, for all potentially hazardous materials implemented in the ESS.		Provided by supplier
Surveillance Cameras	Are there cameras which can record visual conditions inside and/or outside of the ESS service areas? Describe their operation, recording means, transmission, etc.		Provided by supplier
Entry Monitoring	Systems which can indicate an open door, or motion within the service areas of the ESS.		Provided by supplier

22.2.16 Site Preparation & Engineering

The following specifications list the requirements for site preparation and other engineering considerations.

Table 30 Site Preparation & Engineering

Specification Parameter	Description	Units	Value
Building or Outdoor Installation	Representative site drawing.		Provided by supplier
Enclosure Type	A description of the system enclosure including that supplied with the system, provided as a part of the site installation and/or comprised of building assemblies associated with the installation Examples include building, containerized–both stationary and transportable.		Provided by supplier
Foundations Required	Specifications of recommended foundation to achieve full seismic rating.		Provided by supplier
Underground Cabling/Conduit Required	Representative site drawing.		Provided by supplier
Lighting Provided	Specifications		Provided by supplier
Lightning Protection Required/ Provided?	Specifications		Provided by supplier
Ground-Grid Required/Provided	Specifications		Provided by supplier
Crane Requirements (Weight And Size)	Specifications		Provided by supplier

Perimeter Fencing Required/Provided	Specify permanent fence line and temporary construction fence/access requirements.		Provided by supplier

22.2.17 Operations modes and requirements

This section focuses on the operations of the vendor's or project's system operations. This includes specific operational modes, maintenance needs, and required equipment documentation.

Table 31 Operations

Specification Parameter	Description
Stand-Alone Island Mode	The ESS can provide voltage and frequency into a disconnected grid, supplying stable power to its AC loads.
Grid Connected Mode	The ESS can synchronize to a grid in which other power sources are providing a reference voltage and frequency.
P & Q Command Modes	The ESS, while synchronized to a grid, can provide real and imaginary power according to two parameters it is commanded, P and Q.
Frequency Response Mode	The ESS, while synchronized to a grid, can provide real power in response to frequency deviations it measures on the grid to which it is connected.
Frequency Regulation Mode	The ESS, while synchronized to a grid, can provide real power in response to frequency deviations a central controller (e.g. the regional ISO) measures on the grid to which it is connected.
Renewables Ramping	The ESS, while synchronized to a grid, can provide real and reactive power in response to rapid fluctuations of power from a renewable energy source, with the aim of preventing excessive rates of changes of the power at the PCC of a renewable source.
Peak Shaving Mode	The ESS, while synchronized to a grid, can deliver real power in response to a measurement of power flow at a pre-determined point on a grid, with the aim of reducing peak power flow through certain grid assets or meters.
Voltage Regulation Mode	The ESS, while synchronized to a grid can deliver real or imaginary power in response to a voltage measurement at a pre-determined point on a grid, with the aim of regulating voltage at that point: (1) steady-state timeframe application, e.g. ANSI C84 operating voltage and/or (2) transient sag mitigation, which is typically a local-control mode to address temporary voltage dips due to faults on adjacent feeders and other temporary phenomena.
Power Factor Regulation Mode	The ESS, while synchronized to a grid can deliver imaginary power in response to a power-factor measurement at a pre-determined point on a grid, with the aim of increasing the power-factor that that point (steady-state timeframe application, e.g. ANSI C84 operating voltage).
Scheduled Arbitrage Mode	The ESS, while synchronized to a grid can absorb or deliver real power into the grid according to a fixed or programmable schedule.
Schedulable Operation	The ESS can execute various modes of operation according to a preset or programmable schedule.

Specification Parameter	Description
SOC Management Mode	The ESS delivers or absorbs power into an AC grid to maintain its state of charge to within a preset or programmable, desired range.
Independent Phase Balancing	The ESS can control the power to individual phases of its output with the aim of balancing the power flow across all phases of a certain grid asset.
Stackable Modes	Multiple control modes can be enabled concurrently with programmable priorities.
Automatic System Balancing (Power, Load, SOC, etc.)	Multiple modules and segments of the energy storage be balanced with respect to their state of charge, current, power and temperature to maintain the systems optimum state of health.
Accuracy of Reported Discharge/Charge Power	The accuracy of the reported charge/discharge power compared to the actual output.
Automatic Shutdown on Fault	Fault matrix, showing the reaction of the system to all possible and detectable faults.
Automatic Restart on Fault Clear	Table showing the system's response to various faults clearing.
On-Site Control Screen	Can the system be monitored and operated from control panels on site?
Remote Control	Remote monitoring and control.
State of Charge	The control system can monitor the available energy stored in the aggregate energy storage system.
SOC Accuracy	SOC accuracy indication.
State of Health	The control system can monitor the relative health of the energy storage system.
Energy SOH	The control system can monitor the ability of the energy storage system to store energy relative to its beginning of life ability.
Power SOH	The control system can monitor the ability of the energy storage system to deliver or absorb instantaneous power relative to its beginning of life (BOL) through its end of life (EOL) ability.
Efficiency SOH	The control system monitors the power losses with respect to its rated power relative to its beginning of life (BOL) through its end of life (EOL) losses.
Other Data Collection of Operating Conditions	Other data collected by the control system (data elements, refresh rates).
Remote Monitoring of Faults and Status	Data and conditions alarms that are available to remote monitoring systems (data elements, alarms, refresh rates, event recording for data monitored during events, etc.).
Local Data Monitoring	Data and conditions alarms that are available to local data screens for on-site personnel to view (data elements, alarms, refresh rates).
Average Start Up Time	Typical start up time under the specified conditions.
Maximum Start Up Time	In Seconds to be provided by supplier
Typical Shut Down Time	In Seconds to be provided by supplier
Maximum Shut Down Time	In Seconds to be provided by supplier
Control Power UPS Back- Up Time	Expected minimum autonomy time on back-up power (provided by the UPS).
System Behavior when Main Power Is Interrupted	Behavior of system while the control systems are powered by a UPS, or an alternative auxiliary power supply, when the mains power line is shorted or opened.
System Behavior when Mains	Behavior of system when the mains power returns while the control

Specification Parameter	Description
Power Returns	systems are still powered by the UPS or an alternative power source.
System Behavior when Aux Power Recovers	Behavior of system when the auxiliary power returns after an extended power outage (longer than the autonomy time provided by the UPS).
No UPS behavior	Behavior of system, when the auxiliary power is interrupted and if there is no UPS, or if the UPS fails.
Long-Term Down-Time (Hibernation)	Length of time that the ESS remains in a powered down mode before it needs to be turned on and operated to maintain its functionality. (Loss of capacity from regular calendar-life degradation is not considered in this context).
Hibernation Process	Define the process to hibernate the system and restart it for optimal performance.

22.2.18 Maintenance

Table 32 Maintenance

Specification Parameter	Description	Units	Value
Expected Availability of System	Percentage of time that the system is in full operation performing application specific functions taking into account both planned and un-planned down-time.	hr/yr	Provided by supplier
Expected Unplanned Down- Time of System for Repair	Mean Time Between Failures (MTBF) or actual field failure data welcome.	hr	Provided by supplier
Expected Planned Down-Time for Maintenance	Expected time required for regular maintenance and types of maintenance.	hr/yr	Provided by supplier
Expected Service Period between Regular Maintenance	Specify	days	Provided by supplier
Expected Time to Perform Regular Maintenance	Specify	days	Provided by supplier
Expected Service Life before Major Replacement	Specify	years	Provided by supplier
Equipmen t Storage Requirem ents	Environmental requirements to be maintained around spare parts and system components prior to installation and/or during temporary storage, (temperature, humidity, leak containment, etc.) e.g. IEC 60721-3-1.		Provided by supplier
Weather Protection	Protection provided for service personnel during maintenance and installation.		Provided by supplier

22.2.19 Documentation

Table 33 Documentation

Specification Parameter	Description	Units	Value
Operation Manuals	Specify		Provided by supplier
Installation Manuals	Specify		Provided by supplier
Commissioning Manuals	Specify		Provided by supplier
Maintenance Manuals	Specify		Provided by supplier
Service Manuals	Specify		Provided by supplier
Training Manuals	Specify		Provided by supplier

22.3 Drawings

A. Project-specific drawings shall be submitted including the following information as applicable:
   1. Type
   2. Ratings
   3. Size
   4. Quantities
   5. Physical arrangement
   6. Weights
   7. Shipping breakdown / splits
   8. Operation of components and systems
   9. Materials and coatings
   10. External connections
   11. Interconnection with other services
   12. Anchorages, supports and fastening
   13. Installation and coordination with other equipment and materials.

22.4 Catalog Pages / Manufacturer Cut Sheets

A. Manufacturer catalog pages, i.e. cut sheets, are not an acceptable substitute for engineering design documents, except for standard non-engineered products.
B. Catalog pages must be submitted with a cover page clearly indicating the tag number and description of the item(s) covered by the catalog sheet.
C. If multiple components are shown on same page, the applicable line items shall be clearly identified.

22.5 Formats and Quantities

A. Electronic copies of documents and drawings shall be in .PDF format.
B. Final, record copy of project-specific design drawings shall be submitted in .PDF and native CAD format.
C. Contractor shall submit electronic copies plus one hard copy of the “Issued For Construction”, drawings to Company at the same time they are issued to the field. “Issued

For Construction" documents and any subsequent revision shall be signed and sealed by the engineer of record.

D. Final "Conformed to Construction Record" (As-built) documents shall be provided to Company. These documents shall be sealed by the engineer of record; and shall be considered the final record set. Each document issued "For Construction", whether any changes were made during construction or not; shall be revised and sealed for the record set.

22.6 Operation and Maintenance Manuals

A. Prior to final acceptance, prepare and submit three hard copies and one editable electronic file copies of the operations and maintenance manuals that adequately describe the installed equipment and systems.
B. An initial draft of this manual shall be available for review and acceptance prior to the start of testing and commissioning, in order that it may be used for that purpose.
C. As a minimum, such manuals shall include recommended procedures for operation, maintenance, and inspection of the equipment; present pertinent safety considerations; and provide descriptions of major systems, including major equipment, normal operating parameters, and significant control logic.

22.7 Equipment Lists

A. Submit one electronic file of equipment lists, piping lists, valve lists, cable, circuit, and raceway lists, and instrument lists.
B. Resubmit electronic file of any list as revisions are made and issue for construction.
C. Lists shall be electronic sortable data files in either MS-Excel or MS-Access formats.

22.8 Design Calculations

A. Engineering and design calculations prepared during the design are required as submittals.
B. Such calculations include architectural, structural, civil, electrical, and mechanical.

22.9 Bid Submittal List

The contractor is asked to submit the following items with their bid

A. General outline drawing showing overall estimated size and configuration of the BESS container
B. Description, manufacturer's name, and standard descriptive literature for all major BESS system components
C. List of components with lead times longer than 30 days that will be ordered and shipped from another manufacturing facility for assembly in the final plant
D. List of origin of major components, factory manufactured or assembled
E. Location of factory providing the BESS container assembly
F. List of recommended spare parts
G. List of special and maintenance tools to be furnished
H. Supplier's previous experience with proposed equipment
I. List of factory tests
J. Complete description of the extent of shop assembly of components
K. Battery cell data sheet (dimensions, weight, float, and charging voltages etc.)
L. Description of any field assembly work required, including sectional shipments and accessories shipped loose. Include an estimate of man-hours required to complete the field assembly per container
M. Special storage requirements, if applicable
N. Subcontractor list, if applicable
O. Preliminary milestone schedule
P. Staggered shipping schedule, if applicable
Q. Current projected shop loading and shop capacity curves
R. Description of company overview, history, and qualifications
S. Project key team members and org chart
T. Information on bidders Information Security Program
U. Information on the Bidder's Safety program
V. Information on the Bidder's QA/QC program
W. Craft labor rate sheets

X. Financial information such as balance sheet, income statement, sales volume, etc.
Y. Itemized EPC budgetary cost estimate
Z. Overall Bill of Materials
AA. Details of continuing service contracts available to support BESS system after installation
BB. Complete Datasheets provided below

List of Attachments

Attachment A – Overall Site Arrangement
Attachment B – Building Arrangement
Attachment C – Overall One Line Diagram
Attachment D – Not Used
Attachment E – Acceptable Suppliers
Attachment F – Company Safety Standards
Attachment G – Loading Profile
Attachment H – Equipment Data Sheets and Contractor Fill-in Data