

Appendix H

BESS Substantial Completion Test Plan

This **Exhibit** forms an integral part of the Agreement for the [Project Name] (“Project”) between Syrcuit Energy Solutions (the “Owner”) and [Contractor Name] (the “Contractor”). The parties intend that terms appearing in initial capital letters, but not otherwise defined herein, have the meaning defined elsewhere in the Agreement.

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1.0 General

1.1 Definitions

1. **“Battery System”** shall mean a set of battery racks, containing battery modules, within an enclosure integrated with onboard thermal management, Battery Management System (BMS), Fire Protection System (FPS), internal protection, monitoring and other systems as needed within the ESS enclosure(s), certified with applicable codes and standards in Exhibit [●] Scope of Work BESS Section 12.0 Codes and Standards, connected to a single Power Conversion System (PCS) or PCS/Medium-Voltage Transformer (MVT) skid solution.
2. **“Battery System Contractor”** shall mean the party responsible for the supply of the Battery System or Power Unit(s) if a different party than the Contractor.
3. **“BESS Facility”** shall mean all the equipment and services to produce a fully operational Battery Energy Storage System (BESS) from the medium voltage (MV) alternating current (AC) connection point at the Point of Interconnection (POI), through the PCS, and to the DC/BESS.
4. **“BESS Facility EMS”** shall mean the control system, including but not limited to the Energy Management System (EMS) control hardware, software, communication, networking, cybersecurity, and power plant controller (PPC) utilized to send power commands to, monitor, and store data for the Project.
5. **“BESS Power Plant Controller”** or **“PPC”** shall mean the BESS Facility EMS controller that monitors the Unit Controller health and capability and distributes proportional P/Q commands.
6. **“Control Mode”** shall mean the programmed control setting of the BESS Facility EMS.
7. **“Guaranteed Availability”** shall mean the supplied BESS Facility availability guarantee defined in Exhibit [●] Performance Guarantees & Liquidated Damages.
8. **“Guaranteed Energy”** shall mean the Contractor supplied usable energy at the POI (net of Station Power usage) at continuous power (CP) used as defined in Exhibit [●] Performance Guarantees & Liquidated Damages.
9. **“Guaranteed Power”** shall mean the Contractor-supplied Guaranteed Power as defined in Exhibit [●] Performance Guarantees & Liquidated Damages.
10. **“Guaranteed RTE”** or **“Guaranteed Round-Trip Efficiency”** shall mean the Contractor supplied Guaranteed RTE at the POI defined in Exhibit [●] Performance Guarantees & Liquidated Damages.
11. **“HMI”** or **“Human Machine Interface”** shall mean the BESS Facility EMS Web User Interface that shall be used by Supervisory Control and Data Acquisition (SCADA), Owner or Scheduling Coordinator (SC) to interface with the BESS Facility EMS.
12. **“Maximum Charging Capability”** shall mean the maximum charging capability at full power.
13. **“Measured Availability”** shall mean the measured availability of the BESS Facility at the POI by the BESS Facility.
14. **“Measured Energy”** shall mean the measured energy output of the BESS Facility at CP at the POI meter by the BESS Facility EMS.

15. **“Measured Power”** shall mean the measured power output of the BESS Facility at the POI by the BESS Facility EMS.
16. **“Measured RTE”** shall mean the measured RTE of the BESS Facility at full power at the POI by the BESS Facility EMS.
17. **“POI” or “Point of Interconnection”** shall mean the meter located on the primary side of the [TBD] kV Medium Voltage Transformer (MVT) inside the Project substation as shown in the single-line diagram (SLD) in Exhibit [●] Single Line Diagram.
18. **“Power Unit” or “PU”** shall mean a single PCS (bi-directional grid-connected power electronic converter) connected to a Battery System and associated control system. A PU can charge and discharge independently.
19. **“Project”** shall mean the BESS Facility and all the equipment and services to produce a fully operational BESS up to the POI, capable of [Guaranteed Power] MW / [Guaranteed Energy] MWh at BOL.
20. **“Station Power”** shall mean energy used for operating the electric equipment on the site of the BESS facility for the lighting, thermal management system, fire protection system, onboard computers, and office equipment needs of equipment buildings on the site of such a generation facility that are used in the operation, maintenance, or repair of the facility.
21. **“Substantial Completion Test Procedures”** shall mean the performance test procedures in Section 4.0 herein.
22. **“Test Extension”** shall mean any additional time required beyond the test period, to demonstrate BESS Facility operation and performance. The duration of the Test Extension shall be at the sole discretion of the Owner. A Test Extension may be required due to a Test Interruption or weather conditions. All analyses of the test data shall include the data collected during the additional time period due to a Test Extension.
23. **“Test Interruption”** shall mean a time period in which any part of the BESS Facility is partially operational or non-operational due to Owner or Contractor intervention or due to any events outside of Contractor’s control. Data collected during a Test Interruption will not be used to satisfy the requirements of that test and shall be excluded from the analysis of that test.
24. Abbreviations listed below.

1.2 Abbreviations

Table 1 - Abbreviations

AC	Alternating Current
BESS	Battery Energy Storage System
BMS	Battery Management System
CP	Constant Power
DC	Direct Current
DSP	Distribution Service Provider
EMS	Energy Management System
ESS	Energy Storage System
FAT	Factory Acceptance Testing
FPS	Fire Protection System

HMI	Human Machine Interface
ISO	Independent System Operator
MV	Medium Voltage
MVT	Medium-Voltage Transformer
OEM	Original Equipment Manufacturer
PCS	Power Conversion System
POI	Point of Interconnection
PPC	Power Plant Controller
RTE	Round-trip Efficiency
RTU	Remote Terminal Unit
SC	Scheduling Coordinator
SCADA	Supervisory Control and Data Acquisition
SLD	Single Line Diagram
SOC	State of Charge

1.3 Referenced Documents

#	Document Name	Version
1	Exhibit [●] Scope of Work BESS	1
2	Exhibit [●] Single Line Diagram	1
3	Exhibit [●] Performance Guarantees & Liquidated Damages	1
4	Exhibit [●] Hot Commissioning Test Plan (Provided by Vendor)	1
5	Exhibit [●] Hot Commissioning Verification Test Plan (Provided by Vendor)	1

1.4 Points of Contact

General

Item	Description	Company / Mobile / Email
1	Project Engineer	
2		
3		
4		
5		

Site Access

Item	Description	Notes
1	Site Physical Address.	
2	Site Access Instructions	

Site Emergencies

Item	Description	Notes
1	Emergency Response plan for site.	Phone No. - TBD
2	Site Local Fire Dispatch Number.	911 and Owner contact
3	Emergency meet site.	Substation Front Entrance
4	Enclosure fire alarm horn and strobe locations.	Exterior of BESS enclosures

2.0 Purpose

The Substantial Completion Test Procedures are conducted at the Project. Tests are conducted in a grid-tied configuration. Equipment configuration during the test will be managed as is expected during commercial operations subsequent to the successful completion of this test. The system is monitored by internal instrument transformers, external instrument transformers, and metering functionalities to monitor and record voltages, currents, power disturbances, etc.

Each test has a section for Notes/Test Conditions. Test conditions such as extreme weather or abnormal grid conditions should be noted. Because of the amount of time required to run the entire test suite, some of the tests may not be witnessed by the Owner. In such cases, Contractor will run the tests in advance and provide test data. Any testing to be run prior to witness testing shall be confirmed with the Owner in advance.

3.0 Conditions Precedent to Substantial Completion Testing

3.1 Factory Acceptance Testing

Factory Acceptance Testing (FAT) of all relevant equipment, including PCS, Battery Systems, auxiliary equipment, etc., has been successfully completed by Contractor at the Original Equipment Manufacturer (OEM) testing facility.

3.2 Unit Level Commissioning

BESS Facility previously underwent successful Unit-Level Commissioning Completion as defined in Section [●] of the Agreement and Exhibit [●] Hot Commissioning Verification Test Plan.

3.3 Control System Functionality

The BESS Facility EMS shall be successfully configured to receive data from the Battery System BMS, exchange data with the Owner device, transfer data to the Historian Server for the calculation, recording and archiving of data points.

3.4 Communications

Remote Terminal Unit (RTU) testing should be successfully completed during the commissioning process. The interface between Owner's RTU and BESS Facility EMS system should be fully tested and functional prior to starting the rest of the Substantial Completion Test Procedures. This includes verification of data transmission pathway between the Owner RTU and BESS Facility EMS.

4.0 BESS Substantial Completion Test Procedures

4.1 ISO Telemetry Test 1

1. Purpose: The “ISO Telemetry Test 1” is a test to verify communications between the site through the SC to the grid operator, if applicable.
2. Procedure:
 - A. Coordinate the time and date with the grid operator and the SC for telemetry testing.
 - B. Test that the grid operator is receiving the correct status or data, as well as correct data quality, for the following points:
 - i. Station Breaker status
 - ii. Generation Resource High Side Bus Voltage
 - iii. Station Static and/or Dynamic Reactive Device(s) status for each device
 - iv. Station Static and/or Dynamic Reactive Device(s) MVAR output for each device
 - v. Generation Resource auxiliary load and/or station service MW and MVAR

Data Resolution Test Pass/Fail Criteria		
1. Datapoints are received by the grid operator with good quality.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		

Notes/Test Conditions:

4.2 ISO Telemetry Test 2

1. Purpose: The “ISO Telemetry Test 2” is a test to verify communications between the site through the scheduling coordinator to the grid operator, if applicable.
2. Procedure:
 - A. Coordinate the time and date with the grid operator and the SC, if applicable, for telemetry testing.
 - B. Test that the grid operator is receiving correct status or data, as well as correct data quality, for the following points:
 - i. Generation Resource gross and net MW output
 - ii. Generation Resource gross and net MVAR output
 - iii. Switching Device
 - iv. Breaker status
 - v. Generation Resource High Sustainable Limit
 - vi. Generation Resource Low Sustainable Limit

- vii. Generation Resource Automatic Voltage Regulator status
- viii. Generation Resource Power System Stabilizer status
- ix. Maximum Operating State of Charge, in MWh
- x. Minimum Operating State of Charge, in MWh
- xi. State of Charge, in MWh
- xii. Maximum Operating Discharge Power Limit, in MW
- xiii. Maximum Operating Charge Power Limit, in MW

Data Resolution Test Pass/Fail Criteria		
1. Datapoints are received by the grid operator with good quality.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		

Notes/Test Conditions:

4.3 Four-Quadrant Test

1. Purpose: The “Four Quadrant Test” is a performance test to demonstrate control of the site in the four quadrants of the real and reactive power curve.
2. Procedure:
 - A. Coordinate the time and date with the grid operator and the SC, if applicable, for telemetry testing.
 - B. Follow the grid operator's instructions regarding site real and reactive power commands

Data Resolution Test Pass/Fail Criteria		
1. Grid operator observes the expected commands on the POI meter within +/-2%.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		

Notes/Test Conditions:

4.4 BESS Data Resolution Test

1. Purpose: The “Data Resolution Test” is a performance test to demonstrate the capability of the BESS Facility EMS to independently detect and record BESS Facility data. The BESS Facility EMS must be able to measure and record BESS Facility data with a resolution of no less than 60 samples per minute (1-second data resolution).
2. Procedure: This test will be performed on all PU at the same time.
 - A. System Starting State: The BESS Facility will be in the on-line state with each PU at approximately 50% usable state of charge (SOC).
 - B. Command the BESS Facility to discharge at 25% of Guaranteed Power for 5 minutes.
 - C. Command the BESS Facility to follow 0 MW
 - D. Retrieve the data logs from the BESS Facility EMS on-site database.
 - E. Verify all agreed upon values are stored in 1-second data resolution. Datapoints shall include, but not limited to site level data (Voltages, currents, Real Power, Reactive Power, Breaker statuses, etc.), Power unit level data (Voltages, currents, Real Power, Reactive Power, SOC, PCS Status, Battery Status, etc.)
 - F. System End State: The BESS Facility will be in the on-line state and at a commanded active power level of 0 MW.

Data Resolution Test Pass/Fail Criteria		
1. Datapoints are recorded in the BESS Facility EMS historian with a recording rate of no less than 60 samples per minute.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		

Notes/Test Conditions:

4.5 BESS System Startup

1. Purpose: The “System Startup Test” is a performance test to demonstrate the start-up sequence of the BESS Facility.
2. Procedure: This test will be performed on all PUs at the same time.
 - A. Verify on the HMI that all the PCS AC input terminals are energized and voltage values meet OEM specifications.
 - B. Verify on the HMI that all the PCS DC input terminals are energized and voltage values meet OEM specifications depending on battery SOC.
 - C. Verify that all PU Operational State are “Off”, as read on the HMI.
 - D. Start the BESS Facility from the HMI as follows:
 - i. Adjust the Control Mode to operate in BESS-only mode.
 - ii. Send a “Run PQ” command using the HMI.

BESS Facility System Start Up Pass/Fail Criteria					
1. All PUs in the BESS Facility start with no errors as demonstrated on the HMI. All PUs shall be in “On” state and in “Run PQ” in the HMI after step 2Dii.					
PU #	Passed	Failed	Date	Initials	
				Owner	Contractor
1					
2					
3					
Test Performed by:					
Test Witnessed by:					

Notes/Test Conditions:

4.6 BESS System Shutdown

1. **Purpose:** The “Shutdown Test” is a performance test to demonstrate the shut-down sequence of the BESS Facility.
2. **Procedure:** This test will be performed on all PUs at the same time.
 - A. Verify all PUs are running in “Run PQ” as appropriately demonstrated on the HMI.
 - B. Stop all PUs in the BESS Facility from the HMI.

BESS Facility System Shutdown Pass/Fail Criteria					
1. All PUs in the BESS Facility shutdown with no errors as demonstrated on the BESS Facility HMI. All PUs shall be in “Off” state in the HMI after step 2B.					
PU #	Passed	Failed	Date	Initials	
				Owner	Contractor
1					
2					
3					
Test Performed by:					
Test Witnessed by:					

Notes/Test Conditions:

4.7 BESS Emergency Shutdown and Restart

Note: If there is a site-level E-Stop, the EPC will be responsible for testing the functionality of the site-level E-Stop and this test will be omitted from the BESS Contractor test plan.

1. **Purpose:** The “Emergency Shutdown and Restart Test” is a performance test to demonstrate the emergency shutdown and restart sequence of the BESS Facility.
2. **Procedure:** This test will be performed on all PUs at the same time.
 - A. Verify the BESS Facility is running and in “Grid Following” as appropriately demonstrated on the HMI.
 - B. Emergency stop (“E-Stop”) the BESS Facility by issuing an emergency stop command from the HMI.
 - C. Verify that the BESS Facility has stopped.
 - D. Reset the E-stop and reset the BESS Facility fault from the HMI.
 - E. Start the BESS Facility.

BESS Facility Emergency Shutdown and Restart Pass/Fail Criteria					
1. After step 2B, all PUs shall stop immediately, and the PU AC breakers, DC contactors and battery contactors open. All PUs are in a fault state.					
2. PUs shall not restart before step 2D. Verify that PUs are in a latched fault state.					
3. PUs shall start successfully upon completion of step 2E as demonstrated on the HMI.					
PU #	Passed	Failed	Date	Initials	
				Owner	Contractor
1					
2					
3					
Test Performed by:					
Test Witnessed by:					

Notes/Test Conditions:

4.8 BESS Remote Power Setpoint Tracking

- Purpose:** The “Remote Power Setpoint Tracking Test” is a performance test to demonstrate the capability of the BESS Facility to follow remote active and reactive power setpoints.
- Procedure:** This test will be performed on all the PUs at the same time.
 - Verify the BESS Facility is running as appropriately demonstrated in the HMI.
 - Set the BESS Facility Control Mode to manual mode in the HMI.
 - Command active power values of -100%, -50%, 0%, 50%, and 100%
 - Command reactive power values of -100%, -50%, 0%, 50%, and 100%.
 - Record power values in the table below. Measurements will be made at the POI and by the BESS Facility EMS.

BESS Facility Remote Power Setpoint Tracking Test Pass/Fail Criteria			
1. BESS Facility measured response level shall be within $\pm 2\%$ of the expected response level, or <u>XX.X</u> kW/kVAR, the greater of the two.			
Active Power Command (kW)	Active Power Response (kW)	Reactive Power Command (kVAR)	Reactive Power Response (kVAR)
-100%	[XX.X] kW	-100%	[XX.X] kVAR
-50%	[XX.X] kW	-50%	[XX.X] kVAR
0%	[XX.X] kW	0%	[XX.X] kVAR
50%	[XX.X] kW	50%	[XX.X] kVAR
100%	[XX.X] kW	100%	[XX.X] kVAR
-100%	[XX.X] kW	-100%	[XX.X] kVAR
Date:			
Test Performed by:			

Test Witnessed by:	
Owner Initials:	
Contractor Initials:	

Notes/Test Conditions:

4.9 BESS Discharge Capability Test

1. Purpose: The “Discharge Capability Test” is a performance test that demonstrates the discharge capacity of the BESS Facility. The requirement is to achieve Guaranteed Power output within [Site Ramp Rate Requirement] and hold for 10 minutes. This capability is representative of the maximum active power levels.
2. Procedure: This test will be performed on all the PUs at the same time.
 - A. System Starting State: The BESS Facility will be in the on-line state with each PU at approximately 50% useable SOC and at an initial active power level of 0 MW and reactive power level of 0 MVAR.
 - B. Record the BESS Facility active power level at the POI.
 - C. Command the BESS Facility to discharge at the Guaranteed Power rating of [XXX.X] MW.
 - D. Hold the Guaranteed Power command for ten (10) minutes.
 - E. Send a command of 0 MW.
 - F. Record and store the BESS Facility power response. Measurements will be made at the POI meter and by the BESS Facility EMS with a recording in the BESS Facility EMS historian.
 - G. System End State: The BESS Facility will be in the on-line state and at a commanded active power of 0 MW and reactive power of 0 MVAR.

BESS Facility Discharge Capability Test Pass/Fail Criteria		
<ol style="list-style-type: none"> 1. The difference between the BESS Facility active power response and the commanded level shall be +/- 2% as measured by the sum of values at the POI. 2. The time to full output shall be less than or equal to 1s. 3. The hold period of such active power value shall be no less than 10 minutes as recorded in the BESS Facility EMS historian. 		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Notes/Test Conditions:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.10 BESS Charge Capability Test

1. **Purpose:** The “Charge Capability Test” is a performance test that demonstrates the charge capability the BESS Facility. The requirement is to achieve Guaranteed Power within [Site Ramp Rate]s and hold for 10 minutes.
2. **Procedure:** This test will be performed on all PU at the same time.
 - A. System Starting State: The BESS Facility will be in the on-line state with each PU at approximately 50% useable SOC and at an initial active power level of 0 MW and reactive power level of 0 MVAR.
 - B. Record the BESS Facility active power level at the POI.
 - C. Command the BESS Facility to charge at the Guaranteed Power rating of [XXX.X] MW.
 - D. Hold the Guaranteed Power command for ten (10) minutes.
 - E. Command the BESS Facility to follow 0 MW
 - F. Record and store the BESS Facility's active power response. Measurements will be made at the POI and by the BESS Facility EMS with a recording in the BESS Facility EMS historian.
 - G. System End State: The BESS Facility will be in the on-line state and at a commanded active power of 0 MW and MW and reactive power of 0 MVAR.

BESS Facility Charge Capability Test Pass/Fail Criteria

1. The difference between the BESS Facility active power response and the commanded level shall be within +/- 2% as measured at the POI.
2. The time to full output shall be less than or equal to 1s.
3. The hold period of such active power value shall be no less than 10 minutes as recorded in the BESS Facility EMS historian.

Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.11 BESS Reactive Power Capability Test

- 1 Purpose: The “Remote Power Setpoint Tracking Test” is a performance test to demonstrate the capability of the BESS Facility to follow remote active and reactive power setpoints.
- 2 Procedure: This test will be performed on all the PU at the same time.
 - A. System Starting State: The BESS Facility will be in the on-line state with each PU at approximately 50% usable SOC and an initial active power level of 0 MW and reactive power level of 0 MVAR.
 - i. Record the BESS Facility reactive power level at the POI.
 - ii. Command the BESS Facility to follow >20% MVAR absorbing for 10 minutes.
 - iii. Command the BESS Facility to follow 0 MVAR
 - iv. Command the BESS Facility to follow >20% MVAR injecting for 10 minutes.
 - v. Command the BESS Facility to follow 0 MVAR.
 - vi. Record and store the BESS Facility reactive power response. Measurements will be made at the POI and by the BESS Facility EMS with a recording in the BESS Facility EMS historian.
 - vii. System End State: The BESS Facility will be in the on-line state and at a commanded reactive power of 0 MVAR.

BESS Facility Reactive Power Capability Test Pass/Fail Criteria

1. The BESS Facility reactive power response and the commanded level shall be within +/- [2]% as measured at the POI. The time to full output shall be less than 1 second.
2. The hold period of both reactive power values shall be no less than 10 minutes as recorded in the BESS Facility EMS historian.

Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.12 BESS Ramp Rate Validation – Real Power

1. Purpose:
 - A. Demonstrate that proper real power ramp rates as per project requirements have been implemented and the BESS ramps up / down at the expected rates.
 - B. The test is to be performed at the BESS Facility EMS level.
2. Initial Criteria:
 - A. System Starting State: The system will be in the on-line state at ~50% State of Charge (SOC)
 - B. Ramp rate should be set as the following and displaying correctly on the BESS Facility EMS User Interface:
 - i. Ramp Rate Down: [1] MW / min
 - ii. Ramp Rate Up: [1] MW / min
3. Procedure:
 - A. Ensure system is online with a 0MW / 0 MVAR setpoint from BESS Facility EMS.
 - B. Set the system to a power value of [-1] MW.
 - C. Begin a timer.
 - D. The system should ramp to full power in a minimum of [1] [minutes/seconds].
 - E. Hold the system output for one minute.
 - F. Once the system is stable at [-1] MW, input a 0 MW command and observe the system ramp back down to 0 MW.
 - G. The system should ramp to zero power in a minimum of [1] [minutes/seconds].
 - H. Once the system reaches an output of 0 MW, input a [1] MW command.
 - I. Begin a timer.
 - J. The system should ramp to full power in a minimum of [1] [minutes/seconds].
 - K. Once the system is stable at [1] MW, input a 0 MW command and observe the system ramp back down to 0 MW.
 - L. The system should ramp to zero power in a minimum of [1] [minutes/seconds].

Pass/Fail Criteria		
1. System ramps at a power rate of [1] MW/min to \pm [1] MW power output within the expected time interval of [1] [minutes/seconds].		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.13 BESS Ramp Rate Validation – Reactive Power

1. Purpose:
 - A. Demonstrate that proper reactive power ramp rates, as per project requirements, have been implemented and that the BESS Facility ramps up / down at the expected rates.
 - B. The test is to be performed at the BESS Facility EMS level.
2. Initial Criteria:
 - A. System Starting State: The system will be in the online state at ~50% SOC
 - B. Ramp rate should be set as the following and displayed correctly on the BESS Facility EMS Site Controller HMI:
 - i. Ramp Rate Down: [1] MVAR / min
 - ii. Ramp Rate Up: [1] MVAR / min
3. Procedure:
 - A. Ensure system is online with a 0 MW / 0 MVAR setpoint from BESS Facility EMS.
 - B. Set the system to a power value of [-1] MVAR.
 - C. Begin a timer.
 - D. The system should ramp to full power in a minimum of [1] [minutes/seconds].
 - E. Hold system output for one minute.
 - F. Once the system is stable at [-1] MVAR, input a 0 MVAR command and observe the system ramp back down to 0 MVAR.
 - G. The system should ramp to zero power in a minimum of [1] [minutes/seconds].
 - H. Once the system reaches an output of 0 MVAR, input a [1] MVAR command.
 - I. Begin a timer.
 - J. The system should ramp to full power in a minimum of [1] [minutes/seconds].
 - K. Once the system is stable at [1] MVAR, input a 0 MVAR command and observe the system ramp back down to 0 MVAR.
 - L. The system should ramp to zero power in a minimum of [1] [minutes/seconds].

Pass/Fail Criteria		
1. System ramps at a power rate of [1] MVAR/min to \pm [1] MVAR power output within the expected time interval of [1] [minutes/seconds].		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.14 BESS Energy Capacity and RTE Test

1. **Purpose:** The “BESS Energy Capacity and RTE Test” is a performance test that demonstrates the Measured RTE, Measured Energy, and Maximum Charging Capability.
2. The Contractor shall perform any required OEM’s cell-balancing procedure prior to this test.
3. **Procedure:** This test will be performed on all the PU at the same time.
 - A. System Starting State: The BESS Facility will be in the on-line state and the SOC at each Battery System shall be higher than the SOC at which power limiting occurs (rollbacks or constant voltage). Next, the BESS Facility shall be discharged. As PUs start to power limit, the remaining PUs must maintain their power. As Battery Systems reach 0% discharge power limit, they will immediately be commanded to zero power. This step shall end when each individual PU reaches 0% discharge power limit.
 - B. Record enclosure ambient temperature [or coolant inlet temperatures] measurements and cell temperature measurements for all Battery Systems throughout this test.
 - C. Verify that cell temperature measurements at all Battery Systems are within the OEM required temperature band throughout this test.
 - D. Record the initial values of each Battery System SOC.
 - E. With an initial active power level of 0 MW and reactive power level of 0 MVAR, command the BESS Facility to charge from the POI at the Maximum Charging Capability.
 - F. Stop the charge upon the BESS Facility’s power output falling below 95% of the Maximum Charging Capability.
 - G. Record and store the cumulative AC energy charged to the system as measured at the POI (expressed in MWh AC).
 - H. Following an agreed-upon rest period, command a real power discharge equal to Guaranteed Power.
 - I. Maintain the discharging until the occurrence of any of the following:
 - i. The Contractor’s discretion
 - ii. When each individual Battery System reaches 0% discharge power limit
 - J. Record and store in the BESS Facility’s EMS historian the AC energy discharged from the BESS Facility as measured at the POI. The cumulative AC energy recorded at the POI shall be recorded as the Measured Energy capacity.

The Measured RTE will be calculated as follows:

$$\text{Measured RTE} = \frac{E_{Exp.}}{E_{Imp.}} \times 100\%$$

Where:

- Measured RTE = the actual round-trip efficiency, expressed as a percentage.
- $E_{Exp.}$ = total discharged energy recorded at the POI from Steps H through J in the procedure defined in this section (the “Measured Energy”).
- $E_{Imp.}$ = total import energy measured at the POI from Steps E through G in the procedure defined in this section.

BESS Facility Energy Capacity and RTE Test Pass/Fail Criteria		
1. The Measured RTE at the POI as recorded in the BESS Facility EMS is greater than or equal to the Guaranteed RTE BESS Facility Availability Test Pass/Fail Criteria. 2. The Measured Energy capacity at the POI as recorded in the BESS Facility EMS is greater than or equal to the Guaranteed Energy.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.15 BESS Availability Test

1. **Purpose:** The "Availability Test" is a performance test that demonstrates the BESS Facility is both safe and operational as defined by the procedure below.
 - A. To be valid, the cell temperatures throughout the BESS Facility must be within the OEM required temperature band throughout this test.
 - B. To be valid, the BESS Facility in its entirety shall demonstrate a [Contractor Guaranteed Availability]% availability.
2. **Procedure:** The following criteria shall be met for the Availability Test to be successfully completed. This test will be performed on all the PUs at the same time.
 - A. Record data at 1 second intervals over five (5) consecutive days, each interval will be used to demonstrate the availability.
 - B. If during the Availability Test, any operational issues are discovered or occur which require intervention, the Availability Test may be temporarily stopped for a Test Interruption with approval and at the sole discretion of the Owner. A Test Interruption may require that the Availability Test be extended by a Test Extension. If required, intervention shall be completed during non-production hours when feasible.
 - C. During this test, the BESS Facility shall be exercised in a manner which approximates the operational conditions. A nominal operational activity level shall be maintained. At a minimum, during each 24-hour period of the Availability Test, the BESS Facility shall perform one charge cycle at the Maximum Charging Capability up to the Guaranteed Energy and one discharge cycle at Guaranteed Power down to 0% SOC.
3. **BESS Availability.** The test will demonstrate that the BESS Facility can operate through daily charge-discharge cycles. During the Availability Test, the BESS Facility availability shall be calculated by equation below:

$$\text{Measured Availability} = \left(1 - \frac{1}{H_t \times kW_{np}} \times (\sum_{Incident}^n (H_{un} \times kW_{dr})) \right) \times 100\%$$

Where:

- i) "Total Hours" (H_t) are the total number of hours during the Availability Test, H_t shall not include the hours during a Test Interruption.
- ii) "Nameplate Power" (kW_{np}) equals the Guaranteed Power rating.
- iii) "Incident" shall mean an occurrence of any duration during the Availability Test where any part of the BESS Facility is not fully operational, i.e.:
 - a. A Battery System is disconnected from the DC bus;
 - b. A low DC output voltage (i.e., less than min DC operating voltage) is measured by a Battery System's PCS;
 - c. The BESS Facility has degraded performance, i.e., Measured Power is less than the Guaranteed Power;
 - d. The BESS Facility has an alarm/fault register set which affects the running status of BESS Facility;
 - e. No output power is measured at the AC terminals of the PCS (while PCS is commanded to output power); or
 - f. PCS has degraded performance (Measured Power at the AC terminals of the PCS is less than the commanded power);

For avoidance of doubt, Incidents occurring during a Test Interruption shall be excluded, while those that occur during a Test Extension shall be included in the Availability Test calculation.
- iv) "Incident Component Unavailability" (H_{un}) shall mean, for each Incident, the duration of the period (measured in hours) beginning when any portion of the BESS Facility initially becomes non-operational until the first such time when all of the BESS Facility resumes full operation during the Availability Test.
- v) "Derated System Power" (kW_{dr}): means, for each applicable Incident, the kilowatts of lost BESS Facility power during Incident Component Unavailability. The value for Derated System Power shall be the amount of unavailable AC power during Incident Component Unavailability.

BESS Facility Availability Test Pass/Fail Criteria		
1. The BESS Facility Measured Availability shall demonstrate a minimum availability of <u>[Contractor Guaranteed Availability]</u> %.		
2. The BESS Facility EMS shall demonstrate data availability of <u>[Contractor Guaranteed Availability]</u> %. Verify that no data is lost during the term of the testing period, and no communication failures occur, no function is lost, no software error is discovered, no BESS Facility EMS hardware failure occurs, and no automatic failover of the Site Controller occurs.		
3. The test shall be rerun if any of the criteria are not met after the issue has been addressed.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		

Contractor Initials:	
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Notes/Test Conditions:

4.16 Voltage Regulation Test

1. Purpose: The Voltage Regulation Test, if applicable, is a performance test that demonstrates the capability of the BESS Facility EMS to provide voltage regulation response based on POI voltage as measured by Project POI meter. The BESS Facility EMS should adjust power levels accordingly.
 - A. To be valid, the BESS Facility EMS shall demonstrate test results showing a steady-state voltage regulation accuracy of +/- 0.5% of the controlled voltage at the POI at zero percent (0%) voltage droop and at twenty percent (20%) of the Project's maximum AC output capability.
2. Initial Conditions:
 - A. The BESS Facility is online.
 - B. The BESS Facility EMS is configured to respond to voltage deviations.
 - C. The BESS Facility EMS shall be calibrated such that a command of reactive power will achieve ninety-five (95%) of its final value no later than one (1) second following a step change in voltage. For this test, the "response time" means the period between when the BESS Facility EMS receives the reference voltage set point until the reactive power reaches ninety-five percent (95%) of its final value.
 - D. SOC of BESS Facility is sufficient for charge/discharge evolutions (25%-75%)
3. Procedure: The following criteria shall be met for the Voltage Regulation Test to be successfully completed.
 - A. The Contractor shall measure the response time of the Project's Voltage Regulation by changing the reference voltage using the BESS Facility EMS.
 - B. The Contractor shall perform changes to the reference voltage at two (2) levels of generation, high (>85% of the AC contracted capacity measured at the POI) and low (<30% of the AC contracted capacity measured at the POI). Modulate the BESS Facility EMS reactive power commands to achieve the following voltage changes:
 - i. 1.05 pu to 0.95 pu
 - ii. 0.95 to 1.05 pu
 - iii. Neutral reactive power bus voltage (NBV¹) to NBV + (0.5% or 1%)
 - iv. Neutral reactive power bus voltage (NBV) to NBV – (0.5% or 1%)
 - C. Remove any changes to the reference voltage and command the BESS Facility EMS to follow 0 MVAR.

¹ The "neutral reactive power bus voltage" or "NBV" means the voltage at the POI when the Project is connected to the grid, energized, but not generating reactive power.

Voltage Regulation Test Pass/Fail Criteria		
1. Voltage error of less than +/- one-half percent (0.5%) of the set point at the POI for voltage drop of zero percent (0%);		
2. Voltage regulation system time to reach 95% of its final value is less than or equal to five (5) seconds for all cases;		
3. Voltage overshoot lower than one percent (1%) of final voltage at the POI for all the cases; and		
4. Voltage regulation system deadband does not exceed one-tenth percent (0.1%).		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		

Notes/Test Conditions:

4.17 Power Factor Tests

1. Purpose: The Contractor shall test and verify that while the Project is generating (MW), the BESS Facility shall assist in achieving/maintaining the designated reactive power setpoint.
2. Initial Conditions:
 - A. The BESS Facility is online.
 - B. The BESS Facility EMS is configured to respond to power factor setpoint changes.
 - C. The SOC of the BESS Facility is sufficient for charge/discharge evolutions (25-75%).
3. Procedure: The following criteria shall be met for this test to be successfully completed.
 - A. Command the Project to discharge at 5% of its maximum power output capability and force a reactive power setpoint of +[0.95] pf.
 - B. Command the Project to discharge at 5% of its maximum power output capability and force a reactive power setpoint of 1.0 pf.
 - C. Command the Project to discharge at 5% of its maximum power output capability and force a reactive power setpoint of –[0.95] pf.
 - D. Command the Project to discharge at 5% of its maximum power output capability and force a reactive power setpoint of 1.0 pf.
 - E. Command the Project to discharge at 100% of its maximum power output capability and force a reactive power setpoint of +[0.95] pf.
 - F. Command the Project to discharge at 100% of its maximum power output capability and force a reactive power setpoint of 1.0 pf.
 - G. Command the Project to discharge at 100% of its maximum power output capability and force a reactive power setpoint of –[0.95] pf.
 - H. Command the Project to discharge at 0% of its maximum power output capability and force a reactive power setpoint of 1.0 pf.

Power Factor Test Pass/Fail Criteria		
1. Project provides proper power factor response based on the required power factor parameters within +/- [2]%		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.18 Frequency Response Test

1. Purpose: Validate the Frequency Response functionality of the system to ensure the proper response to a frequency deviation event by the Project outputting the expected amount of active power according to the programmed droop curve, if applicable.
2. Initial Conditions:
 - A. The BESS Facility is online.
 - B. The BESS Facility EMS is configured to respond to frequency deviations.
 - C. The SOC of the BESS Facility is sufficient for charge/discharge evolutions (25%-75%).

Table 1 - Frequency Response Control Test Parameters

Upper Deadband (Hz)	[XX.X] Hz
Lower Deadband (Hz)	[XX.X] Hz
Nominal Frequency (Hz)	[XX.X] Hz
Droop Slope High (Hz/kW)	[XX.X] Hz/kW
Droop Slope Low (Hz/kW)	[XX.X] Hz/kW
Max Discharge (kW)	[XX.X] kW
Max Charge (kW)	[XX.X] kW
Ramp Rate (kW/s)	[XX.X] kW/s

3. Procedure:
 - A. Contact the grid operator and DSP, if applicable prior to performing the test.
 - B. All testing commands will be forced via the BESS Facility EMS to simulate POI frequency.
 - C. The test is performed by adjusting the reference frequency points (e.g., simulating a frequency change at the POI) to push the frequency outside the upper and lower deadbands.

D. Adjust the Hz_Test point to the values defined in the table below.

Table 2 - FR, High Frequency Output Results

Commanded Frequency (Hz)	Expected Active Power (MW)	Commanded Active Power (MW)	Measured Active Power (MW)
60.000	[XX.X] MW	[XX.X] MW	[XX.X] MW
60.036	[XX.X] MW	[XX.X] MW	[XX.X] MW
60.500	[XX.X] MW	[XX.X] MW	[XX.X] MW
61.100	[XX.X] MW	[XX.X] MW	[XX.X] MW

E. Adjust the Hz_Test point to the values defined in the table below.

Table 3 - PFR, Low Frequency Output Results

Commanded Frequency (Hz)	Expected Active Power (MW)	Commanded Active Power (MW)	Measured Active Power (MW)
60.000	[XX.X] MW	[XX.X] MW	[XX.X] MW
59.964	[XX.X] MW	[XX.X] MW	[XX.X] MW
59.500	[XX.X] MW	[XX.X] MW	[XX.X] MW
59.000	[XX.X] MW	[XX.X] MW	[XX.X] MW

F. Write Hz Test setpoint of 60 Hz on the BESS Facility EMS.

G. Restore the BESS Facility EMS functionality to normal state.

Frequency Response Test Pass/Fail Criteria		
1. The BESS Facility EMS properly identifies a change in frequency within the defined parameters and dispatches the BESS Facility to charge/discharge active power appropriately to correct frequency at the POI to bring the frequency value back to nominal.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.19 Voltage Droop Regulation Test

1. **Purpose:** Validate the Voltage Droop Response functionality of the system to ensure the proper response to a voltage deviation event by the Project outputting the expected amount of reactive power according to the programmed droop curve, if applicable.
2. **Initial Conditions:**
 - A. The BESS Facility is online.
 - B. The BESS Facility EMS is configured to respond to voltage deviations.
 - C. The SOC of the BESS Facility is sufficient for charge/discharge evolutions (25%-75%).

Table 4 - Voltage Response Control Test Parameters

Upper Deadband (kV)	[XX.X] kV
Lower Deadband (kV)	[XX.X] kV
Nominal Frequency (kV)	[XX.X] kV
Droop Slope High (kV /kVAR)	[XX.X] kV /kVAR
Droop Slope Low (kV /kVAR)	[XX.X] kV /kVAR
Max Discharge (kVAR)	[XX.X] kVAR
Max Charge (kVAR)	[XX.X] kVAR
Ramp Rate (kVAR/s)	[XX.X] kVAR/s

3. **Procedure:**
 - A. Contact the grid operator and DSP, if applicable, prior to performing the test.
 - B. All testing commands will be forced via the BESS Facility EMS to simulate POI voltage.
 - C. The test is performed by adjusting the reference voltage points (e.g., simulating a voltage change at the POI) to push the voltage outside the upper and lower deadbands.
 - D. Adjust the kV_Test point to the values defined in the table below.

Table 5 - VDR, High Voltage Output Results

Commanded Voltage (kV)	Expected Reactive Power (MVAR)	Commanded Reactive Power (MVAR)	Measured Reactive Power (MVAR)
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR

- E. Adjust the kV_Test point to the values defined in the table below.

Table 6 - VDR, Low Voltage Output Results

Commanded Voltage (kV)	Expected Reactive Power (MVAR)	Commanded Reactive Power (MVAR)	Measured Reactive Power (MVAR)
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[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR
[XX.X] kV	[XX.X] MVAR	[XX.X] MVAR	[XX.X] MVAR

- F. Write kV Test setpoint of nominal voltage on the BESS Facility EMS.
G. Restore the BESS Facility EMS functionality to normal state.

Voltage Droop Regulation Test Pass/Fail Criteria		
1. The BESS Facility EMS properly identifies a change in voltage within the defined parameters and dispatches the BESS Facility to consume/produce reactive power appropriately to correct voltage at the POI to bring the voltage value back to nominal.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.20 AGC Dispatch Follow

- Purpose: Demonstrate the ability of the BESS Facility EMS to follow Active Power setpoint from remote dispatching instructions, if applicable.
- Initial Criteria:
 - The BESS Facility is online. The BESS Facility EMS is configured to respond to remote dispatch setpoints. The SOC of the BESS Facility is sufficient for charge/discharge evolutions (25-75%).

Table 7 - Remote Dispatch Control Test Parameters

Max Discharge (kW)	[XX.X] kW
Max Charge (kW)	[XX.X] kW
Ramp Rate Up (kW/s)	[XX.X] kW/s
Ramp Rate Dn (kW/s)	[XX.X] kW/s

Table 8 - Data Requirements

Start Time of Test:	[HH:MM]
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Stop Time of Test:	[HH:MM]
Data Sampling Rate:	[1] second
Measured Active Power at POI (MW):	[XX.X] MW
Data Source:	[RTAC P]
Commanded Active Power Setpoint (kW):	[XX.X] kW
Data Source:	[RTAC P]

3. Procedure:

- A. The Owner submits a bid for power to ISO for the applicable power value to be tested.
- B. ISO sends dispatch instructions to the site.
- C. Verify that the BESS Facility EMS correctly ramps to the setpoint and holds the setpoint until the dispatch changes to 0 MW.
- D. Once the dispatch is updated, verify the system ramps down to 0 MW and displays a 0 MW dispatching command.

AGC Dispatch Follow Test Pass/Fail Criteria		
1. The BESS Facility responds to the dispatching instructions and maintains the required system output for the correct amount of time.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.21 Restricted Charging / Discharging Test (POI Limiting)

1. Purpose: Validate the active power charging / discharging capacity limits at the POI as implemented by the POI, if applicable.
2. Initial Conditions:
 - A. The BESS Facility is online.
 - B. The BESS Facility EMS is configured for POI Limitation and sends control setpoints to the BESS Facility.
 - C. The SOC of the BESS Facility is sufficient for charge/discharge evolutions (25-75%).
3. Procedure:
 - A. Contact the ISO prior to performing test.
 - B. Set POI limit based on contractual or agreed-upon limits by applicable parties.

- i. POI Limit: [XX.X] MW
- C. All testing commands are to be commanded by the commissioning engineer via the HMI.
- D. Input a command via the BESS Facility EMS that is higher than the maximum defined charge limit and record values in the table below.
- E. Input a command via the BESS Facility EMS that is higher than the maximum defined discharge limit and record values in the table below.

Table 9 - Restricted Charge / Discharging Output Results

POI (MW)	Limit	Active Power Command (MW)	Commanded Active Power (MW)	Measured Active Power (MW)
[XX.X] MW		[XX.X] MW	[XX.X] MW	[XX.X] MW
[XX.X] MW		[XX.X] MW	[XX.X] MW	[XX.X] MW

Restricted Charging / Discharging Pass/Fail Criteria		
1. The BESS Facility EMS is to properly cap the charge/discharge commands and not send any active power commands to the BESS higher than these defined limits.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:

4.22 Loss of Communications Test – BESS Facility EMS to POI Meter

1. Purpose: This test demonstrates the BESS Facility properly handles a loss of communication scenario between the PPC and the POI Meter. Desired behavior for this scenario is that after 60 seconds of loss of communications between the PPC and the POI (as indicated by a stale heartbeat) is for the PPC to command the BESS Facility Site Controller to ramp down power output to 0 MW / 0 MVAR. Upon restoration of communications, the BESS Facility EMS should direct the BESS Facility Site Controller to ramp back up to the requested power value from the BESS Facility EMS.
2. Initial Conditions:
 - A. BESS Facility is online in grid following mode
 - B. The BESS Facility EMS is commanding BESS Facility at a value > 0 MW and/or 0 MVAR

3. Procedure:

- A. Ensure BESS Facility is outputting proper power output.
- B. Monitor the heartbeat value correlating to the communication health between the BESS Facility EMS and the POI Meter.
- C. Physically disconnect the network connection between the POI Meter from the main network.
- D. Observe heartbeat stops updating and start timer
- E. After ~60 seconds, the BESS Facility EMS should initiate a “Loss of Communications Warning - Meter”
- F. Immediately following the warning, the BESS Facility EMS should command the BESS Facility Site Controller to begin ramping down to 0 MW / 0 MVAR output at a rate of [XX.X] MW/sec and [XX.X] MVAR/sec.
- G. Stop timer when BESS Facility output reaches 0 MW / 0 MVAR and record time.
- H. Physically reconnect the network connection to the POI Meter.
- I. Observe heartbeat resumes normal behavior (counting).
- J. Observe the BESS Facility EMS commands BESS Facility Site Controller to ramp back to the requested dispatch power.

Loss of Communications Test – BESS Facility EMS to POI Meter Test Pass/Fail Criteria		
1. The POI Meter Heartbeat goes stale after disconnection		
2. After ~ 60 seconds after initial loss of communications, the BESS Facility EMS directs BESS Facility to ramp power output down to 0MW / 0MVAR		
3. After re-establishing connection to POI meter, the BESS Facility EMS directs the BESS Facility to ramp back up to commanded power.		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Owner Initials:		
Contractor Initials:		

Notes/Test Conditions:
