

Exhibit F-5
BESS Substantial Completion Test Plan

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1.0 General

1.1 Definitions

- A. **“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 A-1 Scope of Work BESS Section 6.0 Codes and Standards, connected to a single Power Conversion System (PCS) or inverter.
- B. **“Battery System Supplier”** shall mean the party responsible for the supply of the Battery System or Power Unit(s) if a different party than the Contractor.
- C. **“BESS Facility”** shall mean all the equipment and services to produce a fully operational Battery Energy Storage System (BESS) from the medium voltage (MV) AC connection point at the Substation, through the Power Conversion System (PCS) and to the DC/Battery energy storage system.
- D. **“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 PPC utilized to send power commands to, monitor and store data for the Project.
- E. **“Control Mode”** shall mean the programmed control setting of the EMS.
- F. **“Guaranteed Availability”** shall mean the supplied BESS Facility availability guarantee defined in Exhibit E-1 Performance Guarantees & Liquidated Damages.
- G. **“Guaranteed Energy”** shall mean the Contractor supplied useable energy at the POI (net of Station Power usage) at continuous power (CP) used as defined in Exhibit E-1 Performance Guarantees & Liquidated Damages.
- H. **“Guaranteed Power”** shall mean the Contractor supplied Guaranteed Power as defined in Exhibit E-1 Performance Guarantees & Liquidated Damages.
- I. **“Guaranteed RTE”** shall mean the Contractor supplied Guaranteed RTE at the POI defined in Exhibit E-1 Performance Guarantees & Liquidated Damages.
- J. **“HMI” or “Human Machine Interface”** shall mean the EMS Web User Interface that shall be used by Supervisory Control and Data Acquisition (SCADA), Owner or PREPA to interface with EMS.
- K. **“Maximum Charging Capability”** shall mean the maximum charging capability at full power.
- L. **“Measured Availability”** shall mean the measured availability of the BESS Facility at the POI by the BESS Facility.
- M. **“Measured Energy”** shall mean the measured energy output of the BESS Facility at CP at the POI meter by the BESS Facility EMS.
- N. **“Measured Power”** shall mean the measured power output of the BESS Facility at the POI by the BESS Facility EMS.

- O. **“Measured RTE”** shall mean the measured RTE of the BESS Facility at full power at the POI by the BESS Facility EMS.
- P. **“MTR” or “Minimum Technical Requirements”** shall mean the application / functionality requirements of the EMS as defined in Exhibit A-2 - Scope of Work EMS/PPC.
- Q. **“POI” or “Point of Interconnection”** shall mean the meter located on the primary side of the 115 kV GSU Transformer inside the PREPA Project substation as shown in the SLD in Exhibit D-1 Single Line Diagram.
- R. **“Power Unit”** shall mean a single PCS (bi-directional grid-connected power electronic converter) connected to a Battery System and associated control system. A Power Unit is able to charge and discharge independently.
- S. **“PPC” or “Power Plant Controller”** shall mean the site-level Power Plant Controller used to control the solar PV and BESS Facility as a single resource at the Point of Interconnection (POI).
- T. **“Project”** shall mean the BESS Facility and all the equipment and services to produce a fully operational BESS up to the POI, capable of 31.5 MW / 10.5 MWh at BOL; AC coupled Solar PV 60 MW and Substation equipment.
- U. **“Site Controller”** shall mean the BESS Facility EMS controller that monitors the Unit Controller health and capability and distributes proportional P/Q commands.
- V. **“Station Power”** shall mean energy used for operating the electric equipment on the site of a generation facility located in the [location] or for the heating, lighting, air-conditioning and office equipment needs of buildings on the site of such a generation facility that are used in the operation, maintenance, or repair of the facility.
- W. **“Substantial Completion Test Procedures”** shall mean the performance test procedures in Section 5.0 herein.
- X. **“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.
- Y. **“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.
- Z. Abbreviations listed below.

1.2 Abbreviations

Table 1 - Abbreviations

BESS	Battery Energy Storage System
BMS	Battery Management System
RBMS	Rack Level BMS (per Battery Rack)
CP	Constant Power

CPR	Cardiopulmonary Resuscitation
EMS	Energy Management System
FAT	Factory Acceptance Testing
HMI	Human Machine Interface
JHA	Job Hazard Analysis
LOTO	Lock Out / Tag Out
MV	Medium Voltage
OEM	Original Equipment Manufacturer
PPE	Personal Protective Equipment
RTAC	Real Time Automation Controller – SEL 3530 device or equivalent
RTE	Roundtrip Efficiency
RTU	Remote Terminal Unit
SAT	Site Acceptance Testing
SCADA	Supervisory Control and Data Acquisition
SOC	State of Charge

1.3 Referenced Documents

#	Document Name	Version
1	Exhibit A-2 Scope of Work EMS	1
2	Exhibit D-1 Single Line Diagram	1
3	Exhibit E-1 Performance Guarantees & Liquidated Damages	1
4	Exhibit F-3 Hot Commissioning Test Plan	1
5	Exhibit F-4 Unit Commissioning Test Plan	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 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 Safety

3.1 Overview

The use of Personal Protective Equipment (PPE) during the performance of procedures outlined in this document is required.

Only authorized personnel will be allowed in the test area, and all authorized personnel and equipment operators will wear PPE in accordance with the arc flash labels relevant to that gear.

Authorized personnel will isolate and Lock-Out/Tag-Out (LOTO) all energy sources feeding a device to verify zero energy.

Before starting any procedure, authorized personnel must identify and adhere to current policies including but not limited to appropriate training, approach distances, safety equipment, Job Hazard Analysis (JHA), and LOTO.

At no time during the energizing, shall any personnel be within 50 feet of pad mount transformers and Switch Gear being energized, and covered under this procedure.

All personnel shall maintain this distance until specifically released by the Project Engineer.

Contractor will have personnel trained in CPR and proper PPE required for electrical installations including MV electrical equipment during the project installation. In the event of a medical emergency, arc flash and/or fire, site personnel should call 911 or local emergency responders.

3.2 Lock Out/Tag Out (LOTO)

LOTO is an acronym for Lock Out/Tag Out. LOTO Procedure should also follow Owner's Health and Safety requirements.

4.0 Conditions Precedent to Substantial Completion Testing

4.1 Factory Acceptance Testing

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

4.2 Unit Level Commissioning

BESS Facility previously underwent successful Commissioning Completion as defined in Section 3.5.2 of the Agreement and Exhibit F-4 Unit Commissioning Test Plan.

4.3 Control System Functionality

The BESS Facility Energy Management System (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.

4.4 Communications

Remote Terminal Unit (RTU) testing should be successfully completed during the commissioning process. The interface between Owner's RTU and BESS 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 EMS.

5.0 Substantial Completion Test Procedures

5.1 BESS System Startup

1. Purpose: The "System Startup Test" is a performance test to demonstrate the start-up sequence of all Power Units in the BESS Facility.
2. Procedure: This test will be performed on all Power Units at the same time.
 - A. Verify on the EMS Human Machine Interface (HMI) that all the PCS AC input terminals are energized and voltage values meet vendor specifications.
 - B. Verify on the HMI that all the PCS DC input terminals are energized and voltage values meet vendor specifications depending on battery State of Charge (SOC).

- C. Verify that all PCS 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 BESS HMI.

System Start Up Pass/Fail Criteria				
All Power Units start with no errors as appropriately demonstrated on the HMI. Units shall be in “On” state and in “Run PQ” on the HMI after step 2D.				
Date	Power Unit #	Passed	Failed	Notes / Test Conditions
Test Performed by:				
Test Witnessed by:				

5.2 BESS Shutdown

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

System Shutdown Pass/Fail Criteria				
All Power Units shutdown with no errors as appropriately demonstrated on the HMI. All Power Units shall be in “Off” state on the HMI after step 2B.				
Date	Power Unit #	Passed	Failed	Notes / Test Conditions
Test Performed by:				
Test Witnessed by:				

5.3 BESS Emergency Shutdown and Restart

1. **Purpose:** The “BESS 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 Power Units at the same time.
 - A. Verify the BESS Facility is running and in “Run PQ” as appropriately demonstrated on the HMI.
 - B. Emergency 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.

Emergency Shutdown and Restart Test Pass/Fail Criteria				
<ul style="list-style-type: none">After step 2B, all Power Units shall stop immediately, and the Power Units AC breakers and DC contactors open. All Power Units are in a fault state.Power Units shall not restart upon before of step 2D. Verify that Power Units are in a latched fault state.Power Units shall start successfully upon completion of steps 2D and 2E as demonstrated by an appropriate state on the HMI.				
Power Unit #		Passed	Failed	Date
Date:				
Test Performed by:				
Test Witnessed by:				
Notes / Test Conditions:				

5.4 BESS Remote Power Setpoint Tracking

1. **Purpose:** The “BESS 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 Power Units at the same time.
 - A. Verify BESS Facility is running as appropriately demonstrated on the HMI.
 - B. Set BESS Facility Control Mode to manual mode in the HMI.
 - C. Command active power values of -100%, -50%, 0%, 50%, and 100%
 - D. Command reactive power values of -100%, -50%, 0%, 50%, and 100%.
 - E. Record power values in the table below. Measurements will be made at the POI and by the BESS Facility EMS.

Remote Power Setpoint Tracking Test Pass/Fail Criteria			
BESS Facility measured response level shall be within $\pm 1\%$ of the expected response level.			
Active Power Command (kW)	Active Power Response (kW)	Reactive Power Command (kVAR)	Reactive Power Response (kVAR)
-100%		-100%	
-50%		-50%	
0%		0%	
50%		50%	
100%		100%	
-100%		-100%	
Date:			
Test Performed by:			
Test Witnessed by:			
Notes/ Conditions:			

5.5 BESS Discharge Capacity Test

- Purpose:** The “BESS Discharge Capacity Test” is a performance test that demonstrates the discharge capacity of the BESS Facility. The requirement is to achieve Guaranteed Power of output within 1s and hold for 10 minutes. This capability is representative of the maximum active power levels.
- Procedure:** This test will be performed on all Power Units at the same time.
 - System Starting State:** The BESS Facility will be in the on-line state with each Power Unit at approximately 50% usable SOC and at an initial active power level of 0 MW and reactive power level of 0 MVAR.
 - Record the BESS Facility active power level at the POI meter.
 - Command the BESS Facility to discharge at the Guaranteed Power rating.
 - Hold the Guaranteed Power command for ten (10) minutes.
 - Send a command of 0 MW.
 - Record and store the BESS Facility power response. Measurements will be made at the POI reference meter and by the BESS Facility EMS with a recording in the EMS historian.
 - 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.

Discharge Capacity Test Pass/Fail Criteria
<ul style="list-style-type: none"> The difference between the BESS Facility active power response and the commanded level shall be $\pm 1\%$ as measured by the sum of values at the POI. The time to full output shall be less than or equal to 1s.

<ul style="list-style-type: none"> 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:		

5.6 BESS Charge Capacity Test

- Purpose:** The “BESS Charge Capacity Test” is a performance test that demonstrates the BESS Facility charge capacity. The requirement is to achieve Guaranteed Power within 1s and hold for 10 minutes.
- Procedure:** This test will be performed on all Power Units at the same time.
 - System Starting State:** The BESS Facility will be in the on-line state with each Power Unit at approximately 50% usable SOC and at an initial active power level of 0 MW and reactive power level of 0 MVAR.
 - Record the BESS Facility active power level at the POI.
 - Command the BESS Facility to charge at the Guaranteed Power rating.
 - Hold the Guaranteed Power command for ten (10) minutes.
 - Command the BESS Facility to follow 0 MW
 - Record and store the BESS Facility active power response. Measurements will be made at the POI and by the BESS Facility EMS with a recording in the EMS historian.
 - 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.

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

5.7 BESS Reactive Power Test

- Purpose:** The “BESS Reactive Power Test” is a performance test that demonstrates the Reactive Power

Production capability of the BESS Facility.

2. **Procedure:** This test will be performed on all Power Units at the same time.
 - a. **System Starting State:** The BESS Facility will be in the on-line state with each Power Unit at approximately 50% usable SOC and at 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 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.

Reactive Power Test Pass/Fail Criteria		
The BESS Facility reactive power response and the commanded level shall be within +/-3% as measured at the POI. The time to full output shall be less than 1 second. 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:		
Notes/Test Conditions:		

5.8 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.
2. **Procedure:** This test will be performed on all Power Units at the same time.
 - A. **System Starting State:** The BESS Facility will be in the on-line state with each Power Unit at approximately 50% usable 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 EMS on-site database.
 - E. Verify values for timestamps, data resolution, system frequency and BESS Facility output (MW).
 - 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		
BESS Facility MW active power response to deployment and system frequency will be recorded in the 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:		

5.9 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.
 - A. To be valid, the cell temperatures throughout the BESS Facility must be within the OEM required temperature band throughout this test.
2. The Contractor shall perform any required manufacturer’s cell balancing procedure prior to this test.
3. **Procedure:** This test will be performed on all Power Units 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 P-limiting occurs (rollbacks or constant voltage). Next, the BESS Facility shall be discharged. As Power Units start to P-limit, the remaining Power Units must maintain their power. As Battery Systems reach 0% of their share of the power command, they will immediately be commanded to zero power. This step shall end when each individual Power Unit reaches 0% P-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 initial values of each Battery System SOC.
 - E. With an initial active power level of 0 MW and reactive power level of 0 MVAR, next command the BESS Facility to charge from the POI at the Maximum Charging Capability.
 - F. Stop the charge upon the occurrence of any of the following:
 - i. Contractor’s discretion
 - ii. The BESS Facility power falls below 95% of the Maximum Charging Capability
 - G. Record and store the cumulative AC energy charged to the system as measured at the POI.
 - H. Within 5 minutes command a real power discharge equal to Guaranteed Power.
 - I. Maintain the discharging until the occurrence of any of the following:
 - i. Contractor’s discretion
 - ii. When each individual Battery System reaches 0% P-limit
 - iii. The BESS Facility power falls below 95% of the Maximum Charging Capability
 - 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 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 energy recorded at the POI from Step I in the procedure defined in this section (the “Measure Energy”).
- $E_{Imp.}$ = total import energy measured at the POI from Step F in the procedure defined in this section.

For the avoidance of doubt, it is understood that the Contractor’s anticipated Round Trip Efficiency calculations may differ with the above, the Measured RTE is a BESS Facility metric.

Pass/Fail Criteria		
<ul style="list-style-type: none"> • The Measured RTE at the POI as recorded in the EMS is greater than or equal to the Guaranteed RTE. • The Measured Energy capacity at the POI as recorded in the EMS is greater than or equal to the Guaranteed Energy. 		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		

5.10 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. Prior to commencement of this test, all Power Units shall have successfully completed unit-level commissioning and be operational.
 - A. To be valid, the cell temperatures throughout the BESS must be within the OEM required temperature band throughout this test.
 - B. To be valid, the BESS Facility in its entirety shall demonstrate a 99.9% availability.
2. **Procedure:** The following criteria shall be met for the Availability Test to be successfully completed. This test will be performed on all Power Units 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 environment. 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:

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

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 or DC-DC converter;
 - c. The BESS Facility has degraded performance, i.e., Measured Power is less the Guaranteed Power;
 - d. The BESS Facility has an alarm/fault register set which affect the running status of BESS;
 - e. No output power is measured at the AC terminals of the PCS (while PCS is commanded to output power);
 - 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 power during Incident Component Unavailability. The value for Derated System Power shall be the amount of unavailable AC power during Incident Component Unavailability.

Availability Test Pass/Fail Criteria		
<ul style="list-style-type: none"> The BESS Measured Availability shall demonstrate a minimum availability of [99.9]%. . The EMS shall demonstrate data availability of 99.9% (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 EMS hardware failure occurs, and no automatic failover of the Site Controller occurs. 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:		
Notes/Test Conditions:		

5.11 Hybrid System - Voltage Regulation System (VRS) Test

1. Purpose: The VRS Test is a performance test that demonstrates the capability of the Project PPC to provide voltage regulation response based on POI voltage as measured by Project POI meter. The Project's PPC should adjust power levels accordingly.
 - a. To be valid, the Project 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 (10%) of the Project's maximum AC output capability.
2. Initial Conditions:
 - A. The BESS Facility, PPC, and PV are online (PV generation is sufficient for inverter operation).
 - B. The PPC is configured to respond to voltage deviations.
 - C. Contractor shall calibrate the voltage regulation application 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 PPC 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 VRS Test to be successfully completed.
 - A. Contractor shall test the time response of the Project's VRS by changing the reference voltage using the PPC.
 - B. 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 PPC reactive power commands to achieve the following voltage changes:
 - (1) 1.05 pu to 0.95 pu
 - (2) 0.95 to 1.05 pu

(3) Neutral reactive power bus voltage (NBV¹) to NBV + (0.5% or 1%)

(4) Neutral reactive power bus voltage (NBV) to NBV – (0.5% or 1%)

C. Remove any changes to the reference voltage and command the PPC to follow 0 MVAR.

VRS Test Pass/Fail Criteria		
<ul style="list-style-type: none">• Voltage error of less than +/- one half percent (0.5%) of the set point at the POI for voltage drop of zero percent (0%);• Voltage regulation system time to reach 95% of its final value is less than or equal to one (1) second for all cases;• Voltage overshoot lower than one percent (1%) of final voltage at the POI for all the cases;• Voltage regulation system deadband does not exceed one tenth percent (0.1%).		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Notes/Test Conditions:		

5.12 Hybrid System - Reactive Power Capability & Minimum Power Factor Tests

1. **Purpose:** 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, PPC, and PV are online (PV generation is sufficient for inverter operation).
 - b. The PPC is configured to respond to power factor setpoint changes.
 - c. SOC of 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 (e.g., 60 MW) and force a reactive power setpoint of +0.85 pf to the Project. Ensure reactive power response is proper to achieve the +0.85 target power factor.
 - b. Command the Project to discharge at 5% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of 1.0 pf to the Project.
 - c. Command the Project to discharge at 5% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of -0.85 pf to the Project. Ensure

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.

reactive power response is proper to achieve the -0.85 target power factor.

- d. Command the Project to discharge at 5% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of 1.0 pf to the Project.
- e. Command the Project to discharge at 100% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of +0.85 pf to the Project. Ensure reactive power response is proper to achieve the +0.85 target power factor.
- f. Command the Project to discharge at 100% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of 1.0 pf to the Project.
- g. Command the Project to discharge at 100% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of -0.85 pf to the Project. Ensure reactive power response is proper to achieve the -0.85 target power factor.
- h. Command the Project to discharge at 0% of its maximum power output capability (e.g., 60 MW) and force a reactive power setpoint of 1.0 pf to the Project.

Reactive Power Capability & Minimum Power Factor Test Pass/Fail Criteria		
<ul style="list-style-type: none"> Project provides proper power factor response based on the required power factor parameters 		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Notes/Test Conditions:		

5.13 Hybrid System - Frequency Response and Regulation Tests

1. Purpose: Contractor shall test and demonstrate the functionality of the Project to comply with the frequency response and regulation MTRs as follows:
2. Requirements:
 - a. Contractor shall ensure that the Project's frequency control shall command the corresponding power output based in the configured frequency response droop and taking into account the frequency dead band.
 - b. The frequency response of the Project should start after the dead band. Contractor shall calculate the magnitude value of the frequency response based on PREPA's operating procedures. Contractor shall not base the value of the response solely on the difference between 60 Hz and the frequency deviation, to avoid a jump or discontinuity in the response.
 - c. If the full magnitude of the frequency response is required, the time response shall be less than one (1) second.
3. Initial Conditions:
 - a. The BESS Facility, PPC, and PV are online (PV generation is sufficient for inverter operation).

- b. SOC of BESS Facility is sufficient for charge/discharge evolutions (25-75%).
4. Procedure: The following criteria shall be met for this test to be successfully completed.
- a. Contractor shall perform part of the frequency response (FR) tests at twenty percent (20%) output power. These tests shall include at least two (2) frequency change rate profiles. Both profiles shall include a complete frequency scan that cover under and over frequencies from a minimum of 59.5 Hz to a maximum of 60.5 Hz. Contractor may obtain these profiles by simulating the grid frequency in the Project's frequency control.
 - i. one (1) profile with a change rate of 10 Hz/min
 - ii. the other of 1 Hz/min
 - b. The frequency response tests of the Project must include two (2) plant active power output levels. Contractor shall perform these in the following stages: (1) ramp rate control activated; and (2) ramp rate control deactivated. Contractor shall demonstrate that the Project can meet the frequency response requirement independently of the ramp rate control requirement (decoupled). Contractor shall conduct a complete test for a two (2) days period where the frequency response of the Project is evaluated due to actual grid frequency variations. The active power output levels as a percent of the maximum AC active power capacity must be:
 - i. above ninety percent (90%)
 - ii. below twenty percent (20%)
 - c. Contractor shall demonstrate that the Project that it is capable of frequency response with the specified three percent (3%) to five percent (5%) droop range, and the control is configurable from three percent (3%) to five percent (5%) in steps of zero point five percent (0.5%), over the operational range of ten percent (10%) to one hundred and ten percent (110%) of the maximum AC active power capacity.
 - d. Contractor shall demonstrate the inverters and power conversion system are capable of assuming the responsibility of discharging during periods of time where the BESS Facility is completely charged (cannot absorb more active power).
 - e. Contractor shall demonstrate the BESS Facility is capable of providing at least ten percent (10%) of the Project maximum AC active power capacity for a period of nine (9) minutes and after the ninth (9) minute the real power shall not decrease at a ramp rate higher than ten percent (10%) of the maximum AC active power capacity per minute. Also, Contractor shall test the energy recovery process for the frequency response implementation of the BESS Facility.

Frequency Response and Regulation Test Result		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Notes/Test Conditions:		

5.14 Hybrid System - Ramp Rate Control Tests

1. Purpose: Contractor shall test and verify the functionality to the Project to comply with the ramp rate control MTRs as follows:
2. Initial Conditions:
 - a. The BESS Facility, PPC, and PV are online (PV generation is sufficient for inverter operation).
 - b. SOC of 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. Contractor shall demonstrate the BESS Facility capability to comply with the minimum nominal power output capacity of thirty percent (30%) of maximum AC active power capacity and for at least one (1) minute, a minimum effective power output capacity of forty-five percent (45%) of maximum AC active power capacity. The transition from effective power output capacity to nominal power output capacity shall not exceed the ramp rate requirement of ten percent (10%) per minute as established in the MTRs. Contractor shall utilize ramp rates for such tests as BESS Facility output power profile resulting from an irradiance reduction profile in the Project from ninety percent (90%) to ten percent (10%) in two (2) minutes (forty percent (40%) per such two (2)-minute period). Contractor shall perform such part of the ramp rate control test with an output power of fifty percent (50%) of the maximum AC active power capacity.
 - b. Contractor shall demonstrate the Project capability to comply with the ramp rate control requirement while it is connected to the grid. This period of testing shall be four (4) days if during this period of time at least five (5) ramp events result in a power drop greater than 30% of maximum AC active power capacity in less than one (1) minute. During two (2) of these four (4)-day test periods, Contractor shall enable the frequency response control to verify that the Project can comply simultaneously with both requirements without any interference. The ramp rate control and the frequency response control shall be decoupled, continuously in operation and the Project shall be able to comply simultaneously with both requirements. If during the four (4)-day test period less than five (5) ramp events occur at the Project, the test will be extended for the number of days necessary. If the five (5) ramp events do not occur but the evaluation demonstrates that the Project is in compliance with the ramp rate control requirement presented in the MTRs during a period often (10) consecutive days, then the Project compliance with the ramp rate control requirement will be deemed as achieved. Contractor shall perform this part of the ramp rate control test with an output power of one hundred percent (100%), but a two (2) days period of similar tests shall be performed with an output power of 50% of the maximum AC active power capacity.
 - c. Contractor shall demonstrate the BESS Facility compliance to the minimum storage capacity requirement for ramp rate control purposes presented in the MTRs of thirty percent (30%) of the Project's contracted capacity output for twenty-five (25) minutes. Simultaneously, Contractor shall also demonstrate the BESS Facility satisfies the minimum storage capacity requirements for frequency regulation purposes of at least nine and one half (9.5) minutes of ten percent (10%) of the Project's contracted capacity output. Contractor shall perform part of the ramp rate control requirement test with output power

less or equal one hundred percent (100%) of the maximum AC active power capacity.

Ramp Rate Control Test Result		
Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Notes/Test Conditions:		

5.15 Hybrid System – Curtailment Test

1. Purpose: Contractor shall perform active power curtailment tests demonstrating the capability of the Project to respond to curtailment signals from the grid operator in compliance with the MTRs.
2. Initial Conditions:
 - a. The BESS Facility, PPC, and PV are online (PV generation is sufficient for inverter operation).
3. Procedure: This test will be performed on all Power Units at the same time. During each of the following steps, record and store the Project's active power response. Measurements will be made at the POI reference meter and with a recording in the EMS historian.
 - a. Command the PPC to discharge at the Project's contracted capacity output. Once the Project power output measured at the POI equals the Project's contracted capacity output, command the Project to follow a simulated grid signal via remote SCADA equal to 20% of the Project's contracted capacity output for 5 minutes. After 5 minutes, set the Project's active power output to 0 MW.
 - b. Command the PPC to discharge at the Project's contracted capacity output. Once the Project power output measured at the POI equals the Project's contracted capacity output, command the Project to follow a simulated grid signal via remote SCADA equal to 40% of the Project's contracted capacity output for 5 minutes. After 5 minutes, set the Project's active power output to 0 MW.
 - c. Command the PPC to discharge at the Project's contracted capacity output. Once the Project power output measured at the POI equals the Project's contracted capacity output, command the Project to follow a simulated grid signal via remote SCADA equal to 60% of the Project's contracted capacity output for 5 minutes. After 5 minutes, set the Project's active power output to 0 MW.
 - d. Command the PPC to discharge at the Project's contracted capacity output. Once the Project power output measured at the POI equals the Project's contracted capacity output, command the Project to follow a simulated grid signal via remote SCADA equal to 80% of the Project's contracted capacity output for 5 minutes. After 5 minutes, set the Project's active power output to 0 MW.

Curtailment Test Pass/Fail Criteria
<ul style="list-style-type: none">• Project successfully responds to remote curtailment command via SCADA

- The Project's active power response and the commanded level shall be within +/-1% as measured by the sum of values at the POI reference meter.
- The time to full output shall be less than 1 second after each command.

Passed	Failed	Date:
Test Performed by:		
Test Witnessed by:		
Notes/Test Conditions:		