

## Employer's Requirements

## Inspection, Testing & Commissioning

**Project:** Engineering, Procurement and Construction of Hybrid PV-Diesel-Battery Energy Storage System

**Location:** Pulau Tiga, Maluku, Indonesia

## **1 Testing and Commissioning Plan**

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The Bidder shall submit an Inspection, Testing and Commissioning Plan within four (4) weeks of the detailed design approval. The Testing and Commissioning Plan shall include, at a minimum, the following information for each significant activity identified in the relevant process:

- A detailed testing and commissioning schedule and description of activity checklists (Design Verification — Installed as designed & specified; labeling and signage in place, clearances);
- A description of isolation requirements (including durations);
- Hold points and witness points;
- All Inspection and Test Reports (ITRs) for the commissioning process;
- A method for addressing defects including punch lists.
- Identification of any risks and mitigation measures

The ITRs shall include the following information, at a minimum:

- Reference to equipment, requirements, drawings and standards;
- Isolation requirements;
- All tests to be performed;
- Acceptance criteria;
- Acceptance by technician;
- Acceptance by the Employer.

Any issues identified during commissioning shall be managed using a punch list. The punch list is to be closed out to the satisfaction of the Employer's Representative prior to handover. The Bidder shall be responsible for performing sufficient tests and inspections to ensure that the system complies with requirements of the Contract. The Bidder shall maintain all sections of the work until such time as the work is deemed practically complete and handed over to the Employer.

### **1.1 Supervision**

The Employer will prepare and submit a supervision work plan to Bidder. Bidder should facilitate and ease supervision visits, prepare site, and provide updates during site visits by Employer and/or PLN.

### **1.2 Test results**

All test results will be recorded on the ITRs and submitted to the Employer as part of the as-built documentation.

### **1.3 Site Acceptance Test**

Site Acceptance Tests shall be performed on all goods received to site. Records shall be kept and submitted to the Employer as part of the as-built documentation.

These tests shall include as a minimum the following:



- Visual inspection of goods for damage, corrosion, discolouration, loose components and leaks.
- Check against the Bidders quality system requirement.
- Any damaged goods shall be identified and put aside for review with the Employer.

## 2 Testing

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The Bidder shall have responsibility for the following:

- Develop equipment commissioning test procedures;
- Involve the Employer's local operators during commissioning;
- Resolve performance problems;
- Correct defects during commissioning or schedule as a punch list deferred defect rectification with the Employer.

The Bidder shall give sufficient notice to the Employer to witness commissioning of the installation.

### 2.1 Pre-commissioning tests

After the Bidder is satisfied that the facilities are complete, the Bidder shall carry out pre-commission tests to confirm readiness for commissioning.

To be clear, at pre-commissioning, it is expected that all work will have been completed to allow connection to the grid, however, the grid connection should not be activated (the Employer will not use the plant until the Completion certificate is issued).

The Bidder shall provide all personnel, tools and equipment (i.e. load bank) required for the performance of the pre-commissioning.

Pre-commissioning tests shall, at a minimum, include connection of a load bank to the facilities at the point of grid connection, to simulate network load, and operation of the system for a minimum of 24 hours, including the following matrix of conditions:

- Maximum, average, and zero estimated load
- Backup power supply operating and not operating
- Solar PV array operating and not operating

Operating metrics for all system components shall remain within design specifications for the test and the system shall meet all load requirements.

### 2.2 Functional guarantee tests

Guarantee Tests shall be conducted by the Bidder, and may be observed by the Employer.

The Bidder shall give the Employer written notice of the expected test and commissioning dates not less than four (4) weeks prior.

The Bidder shall provide a written report demonstrating performance against the tests, along with all raw data or evidence in support of the report. Reporting should be according to the relevant standards (where applicable).

Test comprises two types:

- subsystem tests to be carried out both at commencement of commissioning and directly after 1 year of operation, and
- a whole of system test to be carried out over the first year of operation.

- Tests may be negotiated with the Bidder if necessary to suit proposed technical solutions, but will need to address the same principles.
- System should comply with the renewable energy fraction of 95% as specified in Attachment A – General Requirements.

Upon successful completion of the initial subsystem tests at the start of Commissioning, the Employer shall issue a Provisional Operational Acceptance Certificate (of substantially the same form as the Operational Acceptance Certificate). This shall signify only that the first subsystem test is complete. The Provisional Certificate of Acceptance may be issued for each individual subsystem successfully tested.

A summary of the required tests, followed by a detailed description of each, is set out below.

### 2.3 Subsystem Guarantee Tests

Required test	Comments / purpose	Functional Guarantee
<b>Solar PV arrays, including Power Conditioning equipment, cabling switch- &amp; protection gear</b>		
PV module tests (visual inspection, maximum power tests, open circuit voltage measurement, short circuit current measurement, and thermal imaging hot spot tests)	To verify condition of solar PV modules as installed, with the intent of identifying and replacing any modules with defects. Each module requires inspection, but string level short circuit and open circuit tests may be used.	Solar PV Performance
Weather corrected Performance Ratio test	To verify overall PV system operational efficiency is as per design. Test may be conducted at sub-array or string level if sufficiently sized load bank is not available.	
<b>BESS</b>		
Complete cycle of equalisation charge load Test - Full charge	To verify power and capacity of storage system.  To verify equipment and installation quality. Through repeat test after 1 year of operation, verify consumption of battery life within design curve.	Energy Storage  Power plant continuous load rating  BESS Round Trip Efficiency
<b>Diesel Generator</b>		
Heat run	To verify diesel generators operating within specification at prime load.	Generator Heat Run

### 2.4 Whole of System Guarantee Tests

*To be met throughout 365 day test period*

Required test	Comments / purpose	Functional Guarantee
Subsystems availability	To verify that the availability requirements are met. The system is considered available when all components provided by the Bidder are operating at least 90% of their rated capacity.	Plant Availability
Reliability	To verify facilities are not subject to frequent faults affecting customers. Reliability will be measured as Mean Time Between Failures (MTBF).  Failures include instances of non-availability of the plant as above, and any non-availability of the existing system caused by actions or inactions of the plant provided by the Bidder (for example, this includes instances where the solar PV and BESS are working, but an action by the controller causes the diesel generators to trip, preventing supply to customers).	Plant Reliability
Plant Integration and Renewable Energy Fraction	To verify the control optimality and integration of equipment to deliver high renewable energy fraction over the test period.	Renewable Energy Fraction

## 2.5 Earthing tests

The earthing systems shall be tested in accordance with ENA EG1 to determine the level of EPR associated with a worst case fault. This shall be provided as follows:

- Resistance to ground measurement of each separate earth grid/electrode;
- Resistance to ground of complete earth grid with all bonds, cable sheaths, tails, links in place as required by the earthing design;
- Current injection test of complete earth grid in accordance. This shall be performed by a current injection test with an off frequency supply and frequency specific meter.

Each section of the earth grid shall be isolated for the test with warning signs in place identifying that current injection tests are taking place in the vicinity. If any equipment is connected to the earth grid that will be sensitive to the current injection test, this piece of equipment shall be disconnected for the test.



## **2.6 Monitoring and Control tests**

All aspects of the Monitoring and Control system shall be tested to demonstrate reliable and correct operation and functionality under all operational scenarios, on site and remotely from PLN MMU office in Ambon. All peripheral pieces of equipment shall be tested back through the Monitoring and Control system in accordance with the requirements. System checks will be performed to ensure that the operational functionality is compliant.