



SHAMS DUBAI

CHECKLIST

TESTING AND INSPECTION WITH INTERCONNECTION TO THE GRID

VERSION 1.0 AUGUST 2015

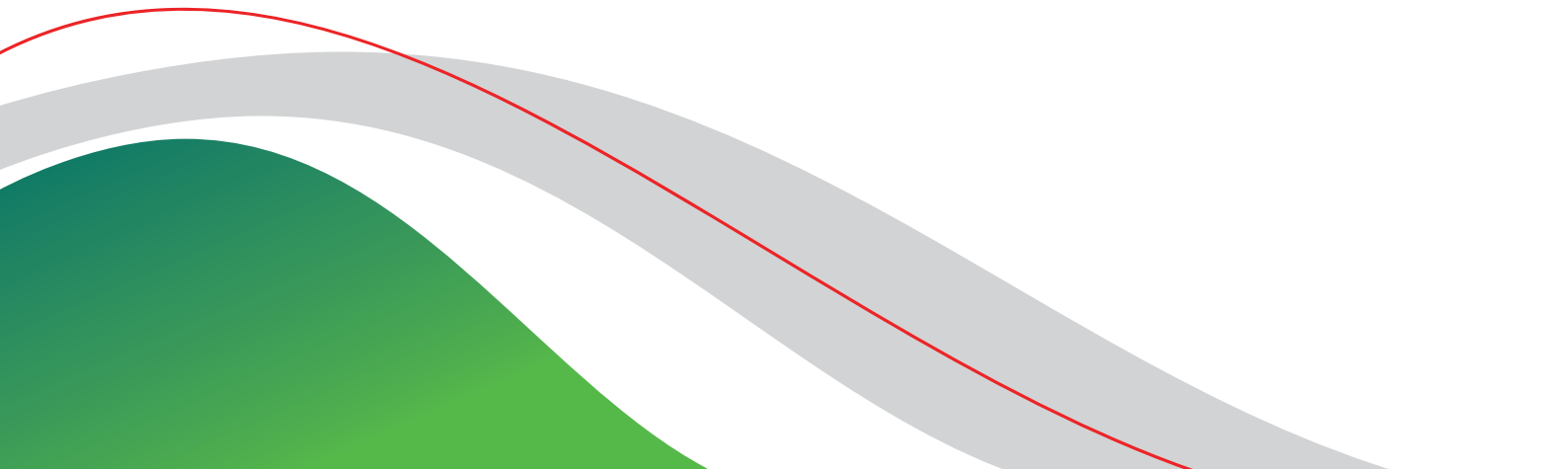


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1 SCOPE

This document presents the layout to be used for the results of Testing and Inspection with Interconnection.

Testing and Inspection activity consists of checks and measurements of selected characteristics.

At completion of the test a Test report has to be prepared. The template for the results is contained within this document.

Participants shall take note of inspection checks and measurements for their own record. The Applicant/ Contractor's Test Engineer shall prepare the Draft Test Report that will be distributed to the participants for their comments and approval.

The testing instruments shall be provided by the Applicant / Contractor and have valid calibration certificates in order to ensure that valid on-site testing can be performed.

1.1 PV PLANT AND INSPECTION DATA

| Name of the PV Plant | Nominal Power (kW) | | | Location of the Plant | |
|------------------------|--------------------|--------------|--------|-----------------------|------|
| | | | | | |
| Type of installation | Rooftop | Flat rooftop | Ground | Pole | BIPV |
| | | | | | |
| Date of the inspection | | | | | |
| | | | | | |

| Name of Test Engineer (1) | Affiliation | Licence / Register ID |
|----------------------------|-------------|-----------------------|
| | Consultant | |

| TESTING AND INSPECTION WITH INTERCONNECTION RESULT | PASSED |
|--|----------|
| | REJECTED |

| Participant | Affiliation | Role |
|-------------|-------------|---------------|
| | Consultant | Designer |
| | Consultant | Test engineer |
| | Contractor | Installer |
| | DEWA | Inspector |

1 Tests are to be carried out by a licensed engineer

2 TESTING EQUIPMENT

| Test equipment | | | | | | |
|---------------------|-------------------------------------|-------|----|-------------------------|--------------------------|--|
| Type of measurement | Manufacturer | Model | SN | Calibration Certificate | Date of last calibration | |
| 1 | DC power | | | | | |
| | Wattmeter | | | | | |
| | DC clamp meter | | | | | |
| 2 | AC power | | | | | |
| | Wattmeter | | | | | |
| | AC clamp meter | | | | | |
| 3 | Test of Interface Protection | | | | | |
| | | | | | | |
| 4 | Performance Test | | | | | |
| | | | | | | |
| 5 | Additional instruments | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

3 DOCUMENTS

3.1 Reference documents and standards

- [1] DEWA Standards for Distributed Renewable Resources Generators Connected to the Distribution Network
- [2] DEWA Connection Guidelines for Distributed Renewable Resources Generators Connected to the Distribution Network
- [3] DEWA Inspection and Testing Guidelines for Distributed Renewable Resources Generators Connected to the Distribution Network

3.2 PV plant design documents (Technical dossier)

A list of documents provided by the Applicant to DEWA will be filled as in the proposed template here below.

Data-sheets and catalogues

| | |
|------|--|
| [1] | |
| [2] | |
| [3] | |
| | |

Technical Reports

| | |
|------|--|
| [1] | |
| [2] | |
| [3] | |
| | |

Drawings

| | |
|------|--|
| [1] | |
| [2] | |
| [3] | |
| | |

4 TESTING WITH INTERCONNECTION TO NETWORK – PERFORMANCE TESTS

4.1 Functionalities of the RRGU/RRGP

These checks and controls can be carried out after the Inspection has been performed, the meter installed and the plant energized with connection to the distribution network.

4.1.1 Connection to grid and start-up of RRGU/RRGP

The test starts by connecting and energizing the equipment of the RRGU / RRG. Each unit of the solar PV generator will receive power from the grid allowing auxiliary services to supply switchboards and AC equipment.

The Test Engineer will specify the tests carried out to verify the electrical installations and the respective outcomes in a table like in the template reported hereinafter (one row for each test).

| Connection to grid and start-up of RRGU/RRGP | | | | | | | |
|---|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|
| Equipment / Switchboard | Doc. ref. | Result | | | Ref. to Note | | |
| The test starts by connecting and energizing the equipment of the RRGU / RRG. Each unit of the solar PV generator will receive power from the grid, allowing auxiliary services to supply switchboards and switchgears up to string combiner boxes. | | | | | | | |
| | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> |
| Note: | 1. | | | | | | |
| | 2. | | | | | | |
| | 3. | | | | | | |

4.1.2 Parallel with the grid

After the plant is connected to the grid and then energized, the checks mentioned below have to be executed. Rows may be added to the proposed table if deemed necessary to specify other tests carried out by the Test Engineer.

| Parallel with the grid | | | | | | | | | |
|------------------------|--|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | The grid connection equipment and related protections are set in accordance with the parameters defined in the Standards | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | The PV power generation and transformation equipment is correctly working and no failures or error messages have been detected | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | 1. | | | | | | | | |
| | 2..... | | | | | | | | |
| | 3..... | | | | | | | | |

4.1.3 Start-up tests on inverters

Tests performed separately on each inverter and progressively throughout the whole RRGU/RRGP, to assess whether the inverters are working properly and are set in accordance with the parameters defined in the Standard [1].

| Start-up tests on inverters | | | | | | | | | |
|-----------------------------|---|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | Cable connections | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Voltage/current input/output values from inverter instruments | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Start-up and shut-down tests | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | 1. | | | | | | | | |
| | 2..... | | | | | | | | |
| | 3..... | | | | | | | | |

4.1.4 Alarms and messages

Alarms and warning messages can help ensure reliable and safe operation of any plant. PV plant equipment may send alarms and warning messages to remote users. According to the plant size, such messages shall be managed by the Installer or by the Owner or by the entity appointed for the "Operation and Maintenance" service. In any case, it is important to check the correct operation of alarms and messages through simulated tests of intervention.

| Alarms and messages | | | | | | | | | |
|-------------------------------|--|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| Describe each check performed | | | | | | | | | |
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | Check alarm "high temperature" in Transformer windings or oil | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Check alarm "high temperature" in Transformer room | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Check alarm high temperature in INVERTER room | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 4 | Check messages going through the monitoring system (or SMS or email) | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | 1. | | | | | | | | |
| | 2..... | | | | | | | | |
| | 3..... | | | | | | | | |

4.1.5 Verification of connection of energy meters

Installation and verification of the energy meter is the responsibility of DEWA. It is recommended that during the Final Inspection, the participants collect the information and that the data is summarized below.

| Verification of connection of energy meters | | | | | | | | | |
|---|---|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | Detect nameplate data of all voltage and current transducers (if any) | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Check connection of meters to voltage/ current transducers, and transformation ratio settings | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Check compliance of meter calibration certificates | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | | 1..... | | | | | | | |
| | | 2..... | | | | | | | |
| | | 3..... | | | | | | | |

4.1.6 Measurements

This part of the tests is devoted to checking that the measuring equipment is in accordance with the technical specifications and that the degree of accuracy of the measurements performed with this equipment will be sufficient.

| Measurements | | | | | | | | | |
|-------------------------------|---|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| Describe each check performed | | | | | | | | | |
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | Equipment, room, and external temperature | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Inverter operational parameters | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Auxiliary services power supply | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | 1. | | | | | | | | |
| | 2..... | | | | | | | | |
| | 3..... | | | | | | | | |

4.1.7 RRGU/RRGP Monitoring system

In accordance with the size of the DRRG (in particular for plants with $P_{MC} \geq 100$ kW), a monitoring system is to be installed to facilitate the management as well as the O&M of the PV plant and to allow DEWA a possible remote monitoring.

The following checks are required to verify the correct behaviour of the system.

| RRGU/RRGP Monitoring system | | | | | | | | | |
|--|--|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| The test shall verify the accordance of the monitoring system to the design, the operation of such system, and the reliability of the measurements. The following checks shall be performed. | | | | | | | | | |
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | Verify the certification of the meteorological sensors: <input type="checkbox"/> solar radiation <input type="checkbox"/> PV module temperature <input type="checkbox"/> pyranometer <input type="checkbox"/> wind <input type="checkbox"/> external air temperature | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Verify the solar radiation sensors by comparing their readings with those of a reference sensor. This test shall concern especially PV plants of Maximum Capacity larger than or equal to 100 kW, for which a performance test is required (see below). The verification of the solar sensors shall ensure that the sensors and instruments of the PV plants are reliable and ensure the PV plant performance can be evaluated any time in the frame of the operation of the PV plant. | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Verify the remote monitoring functions available from the monitoring equipment and system. | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | | 1. | | | | | | | |
| | | 2..... | | | | | | | |
| | | 3..... | | | | | | | |

4.1.8 Operation of electrical systems in each substation

The proper behaviour of the electrical systems in each substation, both for power and auxiliary systems shall be verified. The checks shall be performed by verifying the correct operation of the systems through their instruments, particularly to assess the absence of warning or error messages.

The Test Engineer will specify the tests carried out to verify the electrical installations and the respective outcomes in a table like in the template reported hereinafter (one row for each test).

| Operation of electrical systems in each substation | | | | | | | |
|--|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|
| Describe each check performed | | | | | | | |
| Type of verification /Equipment verified | Doc. ref. | Result | | | Ref. to Note | | |
| | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> |
| Note: | 1. | | | | | | |
| | 2. | | | | | | |
| | 3. | | | | | | |

4.2 Verification of the Technical Dossier

The availability of the as-built designs and documents as well as the documentation of the equipment (e.g. technical specification, installation guide, user's manuals, certifications, etc.) is important for the operation of the PV plant, particularly for the technicians involved in the O&M activity.

Check with reference to delivered documents listed in 3.2.

| Verification of the technical dossier | | | | |
|---------------------------------------|---|----------------|-----------|----------|
| | Description | Doc. available | Doc. ref. | Comments |
| 1 | Layout of PV modules | | | |
| 2 | Layout of inverters | | | |
| 3 | Single Line diagram | | | |
| 4 | Wiring layouts | | | |
| 5 | Structural drawings | | | |
| 6 | Certificates of PV modules, Inverters and other equipment | | | |
| 7 | Electrical installation Test Certificate | | | |
| 8 | Reports | | | |
| 9 | Test of Interface protection | | | |
| 10 | Additional documents | | | |
| Note: | 1. | | | |
| | 2. | | | |
| | 3. | | | |

4.3 Performance Tests

4.3.1 Energy Performance Tests

Test requirements and details

Description of the test

The objective of this test is to prove that the plant is able to produce energy continuously by measuring its Performance Ratio on a given period of time.

Definitions:

- E_{AC} = AC active energy [kWh] at the output of inverter measured in the given period (accuracy $\pm 2\%$)
- P_{nom} = Nominal power of PV generator [kW] (total nominal power of installed modules) @ STC
- Δt_s = Sampling interval [min]
- G = Solar Irradiance [$\frac{W}{m^2}$] sensor coplanar to the surface of the modules (accuracy equal or better than $\pm 5\%$)
- ϑ_{PV} = PV module temperature [$^{\circ}C$]
- γ = Power temperature coefficient of the module [$\%/^{\circ}C$] (this coefficient is usually negative)

The tests can be carried out after successful commissioning and shall last a rolling 10 Days duration accounting for the with the following criteria:

- at least five (5) days with irradiance (G) measured on the plane of the array greater than $600 W/m^2$ for 3 contiguous hours
- for at least five (5) days, the daily total irradiation on the plane of the array exceeds $4.0 kWh/m^2$ (these days may be the same as those indicated in the previous point).
- In the event that the five days are not reached with the required irradiation levels, the measurement period will be extended until the irradiation criteria are achieved.
- Availability of the PV Plant and the grid shall be 100%. In the event of unavailability, the testing period will be extended accordingly by the relevant number of days.
- The sampling interval Δt_s is constant and not larger than 15 min.

Performance ratio without temperature correction (PR)

$$PR = \frac{E_{ac}}{P_{nom} * \Delta t_s \sum_j G_j} * 60 * 10^3$$

Performance ratio with temperature correction (PR_{ϑ})

The temperature correction is useful for comparison among measurements of PR made in different periods. The STC temperature $\vartheta_{REF} = 25^{\circ}C$ is assumed in the formula.

$$PR_{\vartheta} = \frac{E_{ac}}{P_{nom} * \Delta t_s * \sum_j (G_j * [1 + (\vartheta_{pvj} - \vartheta_{REF}) * \gamma / 100])} * 60 * 10^3$$

The Performance Test is carried out for the whole plant, involving the following measurements:

- a) Read active energy as measured by the production meter.
- b) Measurements of the solar irradiance from a reference solar cell or pyranometer connected to a data logger in order to store them in the performance test time span.
- c) Measurements of the PV module temperature by means of a temperature sensor located on the back surface. Values to be sent to the data logger

| Energy Performance tests – Inverter | | | | | | |
|--|---------|------|---|--|---|------|
| Start date (dd/mm/yyyy): ... / ... / | | | Stop date (dd/mm/yyyy): ... / ... / | | | |
| DC | | | AC | | | Note |
| P_{nom} | | kW | PR | | - | |
| θ_{REF} | | °C | PR_{θ} | | - | |
| γ | | %/°C | | | - | |
| Δt_s | | °C | | | | |
| Note: | 1. | | | | | |
| | 2..... | | | | | |
| | 3..... | | | | | |

The active energy which may be produced by the modules, according to the actual operating conditions, as calculated by applying the formula in the box on the previous page, is compared with the measured active energy (by the meter), in order to calculate the Performance Ratio.

4.3.2 Power Performance Tests

The Results for the Power Performance test may be taken directly from the Energy Performance Test as regard an instantaneous set of measurements.

In the checklist of the Power Performance Test additional information must be given because in this case it is possible to report the instantaneous values of the electrical and environmental measurements.

Test requirements and details

Description of the test

The aim of the test is to assess the actual PV plant power.

Definitions:

- P_{DC} = DC power [kW] of the PV generator (accuracy $\pm 2\%$) as measured at the inverter DC input
- P_{AC} = AC active power [kW] at the output of inverter (accuracy $\pm 2\%$)
- P_{nom} = Nominal power of PV generator [kW] (total nominal power of installed modules) @ STC
- N_m = Number of PV modules
- A_m = Area of each PV module [m²]
- G = Solar Irradiance [$\frac{W}{m^2}$] sensor coplanar to the surface of the modules (accuracy equal or better than $\pm 5\%$)
- ϑ_{PV} = PV module temperature [$^{\circ}C$]
- ϑ_{Air} = Air temperature [$^{\circ}C$]
- γ = Power temperature coefficient of the module [$\%/^{\circ}C$] (this coefficient is usually negative)

Tests are valid if Solar Irradiance $G > 600$ [$\frac{W}{m^2}$].

Performance ratio on power without temperature correction (PR_p)

$$PR_p = \frac{P_{AC}}{G} * \frac{1000}{P_{nom}} \quad \eta_{INV} = \frac{P_{AC}}{P_{DC}}$$

Performance ratio on power with temperature correction ($PR_{p,\vartheta}$)

The temperature correction is useful for comparison among measurements made in different periods. The STC reference temperature $\vartheta_{REF} = 25$ $^{\circ}C$ is assumed in the formula.

$$PR_p = \frac{P_{AC}}{G} * \frac{1000}{P_{nom} * [1 + (\vartheta_{PV} - \vartheta_{REF}) * \gamma / 100]} \quad \eta_{INV} = \frac{P_{AC}}{P_{DC}}$$

Array efficiency (sunlight to electricity conversion efficiency of the PV array) (η_A)

$$\eta_A = \frac{P_{DC}}{G * N_m * A_m} * 1000$$

In principle the test is performed for each inverter and related strings of PV modules (array), and is based on the following measurements.

- a) Measure power input to inverter by DC wattmeter (including voltage and current).
- b) Measure power output from inverter by AC wattmeter (single or three-phase electrical quantities) connected to inverter busbar.
- c) DC and AC measurements must be synchronized. Measurements shall be carried simultaneously or in fast sequence, for each subsection (inverter) of RRGU.
- d) Measurements of the solar Irradiance from a reference solar cell or pyranometer.
- e) Measurements of the PV module temperature by means of a temperature sensor located on the back surface

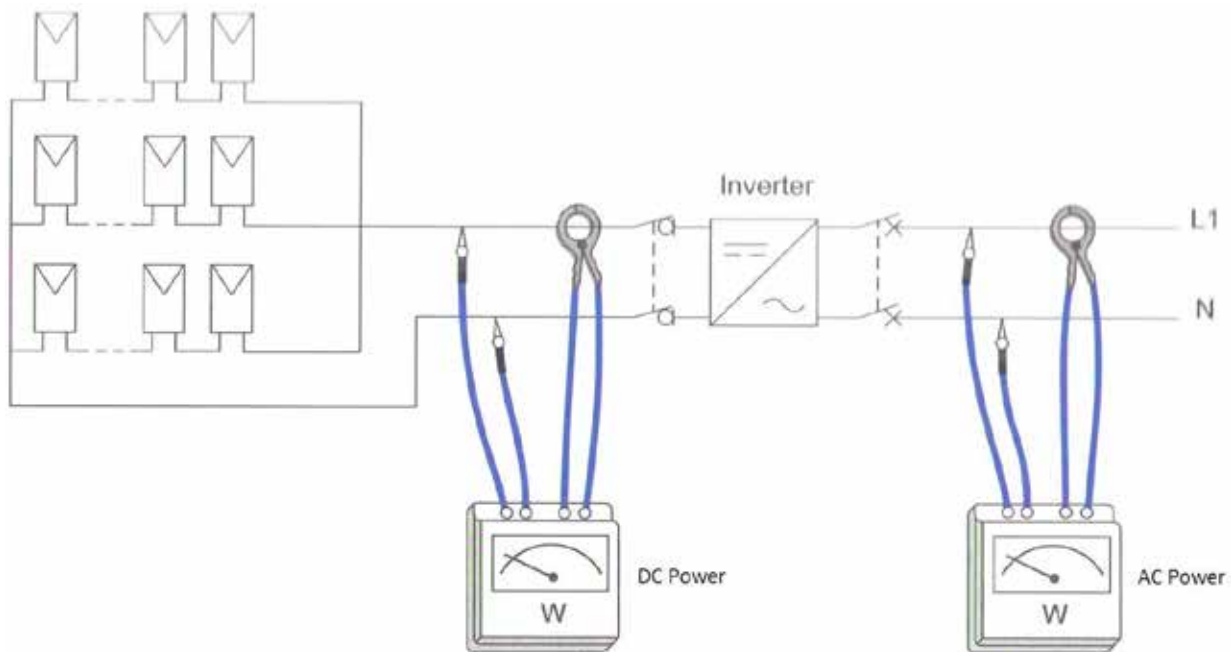


Figure 1 – Measurement of DC and AC power on a PV plant

Power Performance tests – Inverter

Date (dd/mm/yyyy): . . . / . . . /

Hour (hh:mm): . . . / . . .

| DC | | AC | | | Note |
|------------------|---------|------------------|----------------|--|------|
| P_{nom} | | kW | PR_p | | - |
| θ_{REF} | | °C | $PR_{p\theta}$ | | - |
| γ | | %/°C | η_{INV} | | - |
| N_m | | - | η_A | | - |
| A_m | | m ² | P_{ac} | | kW |
| Vdc | | V | Vac1 | | V |
| Idc | | A | Iac1 | | A |
| Pdc | | kW | Vac2 | | V |
| Solar Irradiance | | W/m ² | Iac2 | | A |
| θ_{PV} | | °C | Vac3 | | V |
| θ_{Air} | | °C | Iac3 | | A |
| Note: | 1. | | | | |
| | 2. | | | | |
| | 3. | | | | |

4.3.3 Harmonic Measurements

Assessment of harmonic measurements and analysis of the results.

| Harmonic voltage measurements | | | | | | | | | |
|-------------------------------|---|-------------------------|--------|--------------------------|----|--------------------------|--|--------------|---|
| | | Doc. ref. | Result | | | | | Ref. to Note | |
| 1 | Measurement interval from to | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | | | 1 |
| 2 | Measurement step = 10 minutes | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | | | |
| 3 | N = number of 10-minute intervals in which the supply voltage is within normal operating range | | | | | | | | |
| 4 | N1 = number of 10-minute intervals in which voltage harmonics level exceeds individual harmonic limit and the supply voltage is within normal operating range (for the harmonic voltage limits refer to Table 7 of [1] below annexed) | | | | | | | | |
| 5 | N2 = number of 10-minute intervals in which the THD value for one or more of the phase voltages exceeds the harmonic voltage limits and the supply voltage is within normal operating range (for the harmonic voltage limits refer to Table 7 of [1] below annexed) | | | | | | | | |
| 6 | $N1/N \leq 5\%$ for each individual harmonics and $N2/N \leq 5\%$ for THD during observation period | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | | | |
| 7 | Instrumentation used: Smart meter | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | | | |
| 8 | Instrumentation used: Specific instrumentation | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | | | |
| Note: | | 1.....At least one week | | | | | | | |

Harmonic voltage measurements - Background

| | | Doc. ref. | Result | | | | Ref. to Note |
|---------------|---|-------------|-----------------------|--------------------------|----|--------------------------|--------------|
| 1 | Measurement interval from to | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | 1 |
| 2 | Measurement step = 10 minutes | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | |
| 3 | N = number of 10-minute intervals in which the supply voltage is within normal operating range | | | | | | |
| 4 | N1 = number of 10-minute intervals in which voltage harmonics level exceeds individual harmonic limit and the supply voltage is within normal operating range (for the harmonic voltage limits refer to Table 7 of [1] below annexed) | | | | | | |
| 5 | N2 = number of 10-minute intervals in which the THD value for one or more of the phase voltages exceeds the harmonic voltage limits and the supply voltage is within normal operating range (for the harmonic voltage limits refer to Table 7 of [1] below annexed) | | | | | | |
| 6 | $N1/N \leq 5\%$ for each individual harmonics and $N2/N \leq 5\%$ for THD during observation period | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | 2 |
| 7 | Instrumentation used: Specific instrumentation | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | |
| Odd harmonics | | | Even harmonics | | | | |
| Order h [-] | Harmonic voltage [%]. | Order h [-] | Harmonic voltage [%]. | | | | |
| 3 | | 2 | | | | | |
| 5 | | 4 | | | | | |
| 7 | | 6 | | | | | |
| ... | | ... | | | | | |
| 49 | | 50 | | | | | |
| Note: | 1. At least one week 2. In case the two conditions are not fulfilled, the background harmonics are already above the limits | | | | | | |

Table 7 of [1]: Indicative planning levels for Harmonic Voltages (in % of fundamental voltage) in MV, HV and EHV systems (source IEC/TR 61000-3-6)

| Odd harmonics | | | | | | Even harmonics | | |
|---------------------|-----------------------------|---------------------|---------------------|--------------------|-----|---------------------|-------------------------------|-------------------------------|
| Not multiples of 3 | | | Multiples of 3 | | | | | |
| Order h | Harmonic voltage % | | Order h | Harmonic voltage % | | Order h | Harmonic voltage % | |
| 5 | 5.0 | 2.0 | 3 | 4.0 | 2.0 | 2 | 1.8 | 1.4 |
| 7 | 4.0 | 2.0 | 9 | 1.2 | 1.0 | 4 | 1.0 | 0.8 |
| 11 | 3.0 | 1.5 | 15 | 0.3 | 0.3 | 6 | 0.5 | 0.4 |
| 13 | 2.5 | 1.5 | 21 | 0.2 | 0.2 | 8 | 0.5 | 0.4 |
| $17 \leq h \leq 49$ | $1.9 \times 17 / (h - 0.2)$ | $1.2 \times 17 / h$ | $21 \leq h \leq 45$ | 0.2 | 0.2 | $10 \leq h \leq 50$ | $0.25 \times 10 / (h + 0.22)$ | $0.19 \times 10 / (h + 0.16)$ |

NOTE: The corresponding planning level for the total harmonic distortion is THD = 6.5%

| Harmonic current measurements | | | | | | | |
|-------------------------------|--|---|---|--|---|--------------------------|--------------|
| | | Doc. ref. | Result | | | | Ref. to Note |
| 1 | Measurement interval from to | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | 1 |
| 2 | Measurement step = 10 minutes | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | |
| Order h [-] | Harmonic current [%] in the range 0-25% of rated power | Harmonic current [%] in the range 25-50% of rated power | Harmonic current [%] in the range 50-75% of rated power | Harmonic current [%] in the range 75-100% of rated power | Harmonic current reference [%] ² | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| ... | | | | | | | |
| 50 | | | | | | | |
| Note: | 1. At least one week 2. Harmonics current spectrum declared by RRGU/RRGUs manufacturers | | | | | | |

4.4 Post-connection inspections

4.4.1 Power Performance Tests

If required. To be carried out as in the Chapter Performance Tests

4.4.2 Check the behaviour of energy meters

| Check of correct behaviour of energy meters | | | | | | | | | |
|---|---|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| | | Doc. ref. | Result | | | | | | Ref. to Note |
| 1 | Voltage drop measurements | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Active power instrumental reading | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Check of correctness of protection settings | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| | | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| | | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | | 1..... | | | | | | | |
| | | 2..... | | | | | | | |
| | | 3..... | | | | | | | |

**Verify the proper behaviour of the meters, by means of the following checks
in the internal registries of the meter**

| | | Doc. ref. | Result | | | | | | Ref. to Note |
|--------------|--|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| 1 | Reading of the RMS input currents (OBIS codes 31.7.0, 51.7.0, 71.7.0) | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Reading of the RMS input voltages on the three-phases to verify the balance of the three (OBIS codes 32.7.0, 52.7.0, 72.7.0) | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Reading of the instantaneous active power absorbed (OBIS code 1.5.0) and comparison with power read by other instruments | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 4 | Reading of the instantaneous active power produced (OBIS code 2.5.0) and comparison with power read by other instruments | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| | | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | 1..... | | | | | | | | |
| | 2..... | | | | | | | | |
| | 3..... | | | | | | | | |

Checks and verification of meter connection, certifications and remote reading

| | | Doc. ref. | Result | | | | | | Ref. to Note |
|--------|---|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--------------|
| 1 | Check of the certificate of calibration as released by a recognized calibration laboratory | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Check of the integrity of the sealed parts | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Check of the correct value of the K ratio (VT ratio * CT ratio) as set in the meter in comparison with the actual and rated values of the VT and CT ratios. | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 4 | Check of the correct connections between CTs, VTs and meter | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 5 | Tests of remote reading (from DEWA system) | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| | | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | | | | | | | | | |
| 1..... | | | | | | | | | |
| 2..... | | | | | | | | | |
| 3..... | | | | | | | | | |

Supervise the performance tests "on Power" as repeated by the Applicant on explicit request of DEWA, if considered necessary; and Obtain the reading of the meters in order to begin to consider the exports and net metering

| | | Doc. ref. | Result | | | | | Ref. to Note | |
|--------------|--|-----------|--------|--------------------------|----|--------------------------|-----|--------------------------|--|
| 1 | Reading and recording of the active energy absorbed (OBIS code 1.8.0) from the time of activation of the meter | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 2 | Reading and recording of the active energy produced (OBIS code 2.8.0) from the time of activation of the meter | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 3 | Reading and recording of the reactive energy absorbed (OBIS code 3.8.0) from the time of activation of the meter | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| 4 | Reading and recording of the reactive energy produced (OBIS code 4.8.0) from the time of activation of the meter | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| | | | OK | <input type="checkbox"/> | NO | <input type="checkbox"/> | N/A | <input type="checkbox"/> | |
| Note: | 1..... | | | | | | | | |
| | 2..... | | | | | | | | |
| | 3..... | | | | | | | | |

4.5 Final notes and Observations

In this table all the notes and the observation made at different stages of inspection and testing activities are noted.

| Notes and Observations |
|------------------------|
| [1] |
| [2] |
| [3] |
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