

# Energy Queensland

## Power Quality Guideline for Compliance Reports June 2020



Part of Energy Queensland

# Guideline for reporting PQ in a Compliance Report

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# Guideline for reporting PQ in a Compliance Report

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## 1. PURPOSE AND SCOPE

The purpose of this document is to provide details on how the Power Quality (PQ) parameters are to be presented as part of the Compliance Report (CR).

## 2. DEFINITIONS, ABBREVIATIONS AND ACRONYMS

|     |   |
|-----|---|
| CR  | Compliance Report                       |
| EG  | Embedded Generation                     |
| LV  | Low Voltage, voltage less 1000Vac       |
| MV  | Medium Voltage, voltage greater 1000Vac |
| PQ  | Power Quality                           |
| TDD | Total Demand Distortion                 |
| THD | Total Harmonic Distortion               |

## 3. REFERENCES

|                          |  |
|--------------------------|--|
| STNW 1174                | Energy Queensland Standard for Low Voltage Embedded Generating Connections.  |
| IEEE519                  | Recommended Practice and Requirements for Harmonic Control in Electric Power Systems   |
| AS/NZ 61000.3.7          | Limits - Assessment of emission limits for fluctuating loads in MV and HV power systems  |
| SA/SNZ TR IEC 61000.3.14 | Limits - Assessment of emission limits for harmonics, inter-harmonics, voltage fluctuations and unbalance for the connection of disturbing installations to LV power systems |

## 4. BACKGROUND

A Compliance Report (CR) is to be submitted by the proponent for Embedded Generation (EG) systems greater than 30 kVA. The CR is to be certified by a Registered Professional Engineer of Queensland (RPEQ) to demonstrate the testing/measurements comply with the PQ parameter requirements as set out in the Technical Study document provided by Ergon Energy and Energex for the proposed EG installation.

The PQ requirement within the CR is to demonstrate compliance to power quality parameters of harmonics, flicker and voltage unbalance if required as per the Technical Study. This document provides guidelines on how the harmonics, flicker and unbalance test results must be presented as part of the CR.

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The allocation and measurement of PQ parameters is at the Connection Point. All electrical loads at the customer's installation within the Connection Point shall need to be made active as per normal operating circumstances within the period of measurement.

### 4.1 For EG systems $\leq$ 200 kVA

The minimum period of observation shall be 3 days for power quality data under normal operating conditions.

One day of this period shall be without the EG unit operating.

The data shall capture two repeated cycles from a lowest output to a maximum output and back to the lowest. The two operating cycles shall total to a minimum of 24 hours. The operating output range expected would typically be 10-90% of the approved maximum output of the EG unit.

### 4.2 For EG systems $>$ 200 kVA

The minimum period of observation shall be 7 days for power quality data under normal operating conditions.

One day of this period shall be without the Embedded Generating (EG) unit operating.

For systems above 1.5MVA, a seven days background recording period is required.

### 4.3 Mean of 10-minute values below the 99th percentile

All parameters values should be based on the mean of the 10-minute values below the 99th percentile value. These values should be presented in tabulated form against the allocation values provided by Ergon Energy or Energex. If the 99 percentile value cannot be determined, the mean of all 10 minute values can be used.

Recording equipment should provide recorded values for each phase. Providing the values for each phase is acceptable but the average across the phases is the minimum requirement.

Relevant charts and data files can be provided for information; however, tables are mandatory.

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### 5. HARMONICS

#### 5.1 Low Voltage (LV) Connection

For LV connections, harmonic allocations are provided in current (A) form for individual harmonics from 2-40<sup>th</sup> order as per the example in Table 1. The Total Demand Distortion (TDD<sub>i</sub>) value will also be provided.

**Table 1: Example of Supplied Harmonic Current Emission Limits at 400 V**

| Harmonic Order | Emission Limit at Connection Point (A)<br>(as allocated) | Harmonic Order       | Emission Limit at Connection Point (A) |
|----------------|--|----------------------|--|
| 2              | 6.71   | 22                   | 2.68                                   |
| 3              | 26.84  | 23                   | 4.03                                   |
| 4              | 6.71   | 24                   | 1.02                                   |
| 5              | 26.84  | 25                   | 4.03                                   |
| 6              | 6.71   | 26                   | 1.02                                   |
| 7              | 26.84  | 27                   | 4.03                                   |
| 8              | 6.71   | 28                   | 1.02                                   |
| 9              | 26.84  | 29                   | 4.03                                   |
| 10             | 6.71   | 30                   | 1.02                                   |
| 11             | 12.08  | 31                   | 4.03                                   |
| 12             | 3.03   | 32                   | 1.02                                   |
| 13             | 12.08  | 33                   | 4.03                                   |
| 14             | 3.03   | 34                   | 1.02                                   |
| 15             | 12.08  | 35                   | 1.88                                   |
| 16             | 3.03   | 36                   | 0.48                                   |
| 17             | 10.73  | 37                   | 1.88                                   |
| 18             | 2.68   | 38                   | 0.48                                   |
| 19             | 10.78  | 39                   | 1.88                                   |
| 20             | 2.68   | 40                   | 0.48                                   |
| 21             | 10.73  | TDD <sub>i</sub> (%) | 32.20                                  |

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When presenting the results of the harmonic testing as part of the CR, the results should be presented in a table as shown in Table 2.

**Table 2: Example Table of allocated harmonic limits and test result values - current**

| Harmonic Order             | Emission Limit at Connection Point (A) for Full Load (as allocated)<br>(Example limits) | Emission Test Results EG <u>ON</u> (mean of the 10 min values below the 99th percentile) (A) | Emission Test Results EG <u>OFF</u> (mean of the 10 min values below the 99th percentile) (A) |
|----------------------------|---|--|---|
| 2                          | 6.71  |  |   |
| 3                          | 26.84   |  |   |
| 4                          | 6.71  |  |   |
| 5                          | 26.84   |  |   |
| 6                          | 6.71  |  |   |
| 7                          | 26.84   |  |   |
| 8                          | 6.71  |  |   |
| 9                          | 26.84   |  |   |
| 10                         | 6.71  |  |   |
| 11                         | 12.08   |  |   |
| 12                         | 3.03  |  |   |
| 13                         | 12.08   |  |   |
| 14                         | 3.03  |  |   |
| 15                         | 12.08   |  |   |
| 16                         | 3.03  |  |   |
| 17                         | 10.73   |  |   |
| 18                         | 2.68  |  |   |
| 19                         | 10.78   |  |   |
| 20                         | 2.68  |  |   |
| 21                         | 10.73   |  |   |
| 22                         | 2.68  |  |   |
| 23                         | 4.03  |  |   |
| 24                         | 1.02  |  |   |
| 25                         | 4.03  |  |   |
| 26                         | 1.02  |  |   |
| 27                         | 4.03  |  |   |
| 28                         | 1.02  |  |   |
| 29                         | 4.03  |  |   |
| 30                         | 1.02  |  |   |
| 31                         | 4.03  |  |   |
| 32                         | 1.02  |  |   |
| 33                         | 4.03  |  |   |
| 34                         | 1.02  |  |   |
| 35                         | 1.88  |  |   |
| 36                         | 0.48  |  |   |
| 37                         | 1.88  |  |   |
| 38                         | 0.48  |  |   |
| 39                         | 1.88  |  |   |
| 40                         | 0.48  |  |   |
| <i>TDD<sub>I</sub></i> (%) | 32.20   |  |   |

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### 5.2 Medium Voltage (MV) Connection (11, 22, 33kV)

For Medium Voltage connections, the harmonic allocation values are provided as voltage (V) values in a format similar to Table 1. Again, when presenting the results of the harmonic testing, the results should be based on a minimum recorded period. The values should be presented in a format as shown in Table 3 based on the mean of the 10 minute values below the 99th-percentile value.

**Table 3: CR Table of allocated harmonics and testing result values - Voltage**

| Harmonic Order | Emission Limit at Connection Point (V) for Full Load (as allocated)<br>(Example limits) | Emission Test Results EG with <u>ON</u> (mean of the 10 min values below the 99th percentile) (V) | Emission Test Results with EG <u>OFF</u> (mean of the 10 min values below the 99th percentile) (V) |
|----------------|---|---|--|
| 2              | 0.12  |   |  |
| 3              | 0.24  |   |  |
| 4              | 0.05  |   |  |
| 5              | 1.55  |   |  |
| 6              | 0.09  |   |  |
| 7              | 1.2   |   |  |
| 8              | 0.09  |   |  |
| 9              | 0.33  |   |  |
| 10             | 0.12  |   |  |
| 11             | 2.33  |   |  |
| 12             | 0.11  |   |  |
| 13             | 2.14  |   |  |
| 14             | 0.11  |   |  |
| 15             | 0.18  |   |  |
| 16             | 0.15  |   |  |
| 17             | 1.40  |   |  |
| 18             | 0.15  |   |  |
| 19             | 0.94  |   |  |
| 20             | 0.15  |   |  |
| 21             | 0.15  |   |  |
| 22             | 0.15  |   |  |
| 23             | 1.11  |   |  |
| 24             | 0.15  |   |  |
| 25             | 0.64  |   |  |
| 26             | 0.15  |   |  |
| 27             | 0.15  |   |  |
| 28             | 0.15  |   |  |
| 29             | 0.61  |   |  |
| 30             | 0.18  |   |  |
| 31             | 0.18  |   |  |
| 32             | 0.18  |   |  |
| 33             | 0.18  |   |  |
| 34             | 0.18  |   |  |
| 35             | 0.60  |   |  |
| 36             | 0.18  |   |  |
| 37             | 0.18  |   |  |
| 38             | 0.18  |   |  |
| 39             | 0.18  |   |  |
| 40             | 0.18  |   |  |
| THDv(%)        | 1.89%   |   |  |

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### 5.3 Data Compliance

1. In all cases in which the results (for on and off) exceed the emission limit allocated, it may result in non-compliance and will stop progression of the connection.
2. In the case when the OFF result is breaching the emission limit, please take the following steps:
  - a. Recheck data recorder and consider re-doing the tests.
  - b. Recheck data for the mean of all values below the 99th percentile.
  - c. If the situation remains, please consult the customer/client and advise them the site maybe breaching the connection agreement.
  - d. (provide all data recorded during the period and the recorder details (make and model) for further analysis.)
3. In the case of an ON result breaching the emission limit please take the following steps:
  - a. Recheck data recorder and consider re-doing tests
  - b. Recheck data to the mean of all values below the 99th percentile
  - c. If the situation remains, the customer/client should be advised that mitigation options maybe required.
4. Consideration will be given where the testing shows the site is non-compliant solely due to existing load. In these cases, the customer will be contacted by Ergon Energy or Energex to discuss mitigation actions that will need to be actioned by the customer. The EG System RPEQ should discuss the issue with the customer also.

## 6. FLICKER

The flicker limits for the IES connection are specified as Flicker short term Pst and Flicker long term Plt. The LV flicker limits are allocated as per STNW 1174 and shown in Table 4.

**Table 4: LV Flicker limits**

| Connection Type                    | Pst  | Plt  |
|------------------------------------|------|------|
| Dedicated distribution transformer | 0.50 | 0.40 |
| Shared distribution transformer    | 0.30 | 0.25 |

The measured flicker values should be measured over the same period as harmonics. The measured values should be presented as per Table 5. The maximum value of flicker should never exceed 1.

The site is deemed complaint for flicker when the (absolute) difference between the on and off flicker values is less than the allocated limits for Pst and Plt.



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**Table 5: Flicker values - measured**

|          | Flicker limits as allocated | Measured Flicker with EG <u>ON</u> (mean of the 10 min values below the 99th percentile) | Measured Flicker with EG <u>OFF</u> (mean of the 10 min values below 99th percentile) |
|----------|-----------------------------|--|---|
| $P_{st}$ |                             |  |   |
| $P_{lt}$ |                             |  |   |

LV – The allocated Flicker limits are specified as per STNW1174 and are subject any change of STNW1174.

MV - The Flicker allocation for MV connection are determined and allocated from AS/NZS 61000.3.7.

## 7. VOLTAGE UNBALANCE

The unbalance limits for the IES connection are specified as a percentage of negative sequence for voltage. The LV values are as per STNW1174 and are subject to any change of STNW1174. A copy is shown in Table 6.

**Table 6: Unbalance limits**

| Condition            | Averaging Period | Voltage Unbalance |
|----------------------|------------------|-------------------|
| No Contingency       | 30 minute        | 2.0%              |
| Credible Contingency | 30 minute        | 2.0%              |
| General              | 10 minute        | 2.5%              |
| Once per hour        | 1 minute         | 3.0%              |

Refer to STNW1175 for applicable limits relating to MV connections.

The measured unbalance values should be measured over the same period as harmonics.

The measured values should be presented as per Table 7.

**Table 7: Unbalance value – measured**

|                   | Unbalance limit as allocated | Measured Unbalance (mean of 10 min values below the percentile 99%) IES <u>ON</u> | Measured Unbalance (mean of the 10 min values below the percentile 99%) IES <u>OFF</u> |
|-------------------|------------------------------|---|--|
| General 10 minute | 2.5%                         |   |  |
|                   |                              |   |  |

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### 8. EQUIPMENT

The calibrated equipment used for data measurement purposes shall comply with the relevant standards listed below:

| Parameter   | Relevant Standard                   |
|---|-------------------------------------|
| Methods for measurement and interpretation of results | AS/NZS 61000.4.30                   |
| Class of measurement                                  | Class A of AS/NZS 61000.4.30        |
| Voltage, Amps, Freq, Power Factor, kV, kVA, kVar      | AS/NZS 61000.4.30                   |
| Sample rate   | AS/NZS 61000.4.7                    |
| Total harmonic distortion & harmonics                 | AS/NZS 61000.4.7, AS/NZS 61000.4.30 |
| Flicker   | AS/NZS 61000.4.15                   |
| Voltage and current unbalance                         | AS/NZS 61000.4.30                   |

Information on the equipment used for the calculation is provided within the CR as below.

| Parameter         | Manufacturer, Model |
|-------------------|---------------------|
| Harmonics         |                     |
| Flicker           |                     |
| Voltage unbalance |                     |