Appendix 1 - Documentation

Technical regulation 3.3.1

for battery plants

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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This is a translation of the original Danish regulation text. In case of any discrepancies, the Danish version shall prevail.Revision view

|  |  |  |  |
| --- | --- | --- | --- |
| **Section no.** | **Text** | **Revision** | **Date** |
|  |  |  |  |
| All sections | The regulation was updated following public consultation. This includes:  Editorial errors were corrected.  - Changes were made on the basis of public consultation responses | 1 | 23.06.2017 |
| 5.3.5 | Updated with new requirement to plant properties as regards reactive power | 1 | 23.06.2017 |
| 7 | Updated as regards communication | 1 | 23.06.2017 |
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1. Documentation

Appendix 1 specifies the documentation requirements for the five *plant categories*, see section 1.2.4:

A1. *Battery plants* up to and including 11 kW

A2. *Battery plants* above 11 kW up to and including 50 kW

B. *Battery plants* above 50 kW up to and including 1.5 MW

C. *Battery plants* above 1.5 MW up to and including 25 MW

D. *Battery plants* above 25 MW or connected to over 100 kV.

The documentation, as specified in section 8, must be submitted electronically to the *electricity supply undertaking*.

The technical documentation must include the configuration parameters and configuration data applicable to the *battery plant* at the time of commissioning.

All subsections in the appendix must be filled in for the *battery plant* in question.

If information changes after the time of commissioning, updated documentation must be submitted as required in section 2.2.

A template for Appendix 1 for the various *plant categories* is available on Energinet.dk's website [www.energinet.dk](http://www.energinet.dk).

* 1. Appendix 1 for battery plants

The documentation form must be filled in with data for the *battery plant*, valid at the time of commissioning, and submitted to the *electricity supply undertaking.*

* + 1. Identification

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Plant | Description of the plant: |
| GSRN number |  |
| *Plant owner* name and address: |  |
| *Plant owner* tel. no.: |  |
| *Plant owner* email: |  |
| Inverter – make: |  |
| Inverter – model: |  |
| Inverter – rated power: |  |
| Storage medium – make: |  |
| Storage medium – model no.: |  |
| Storage medium - energy storage capacity at rated inverter power in *POC*: [kW/h] |  |
| Energy storage – runtime at rated inverter power in the *POC*: [kW/h] |  |

* + 1. Tolerance of frequency and voltage deviations

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| The *battery plant* is designed for single-phase connection when neither *Pno* nor *Pnl* exceeds 3.6 kW. | Yes  No |
| The *battery plant* is designed for three-phase connection if neither *Pno* nor *Pnl* exceeds 3.6 kW. | Yes  No |
| The *electricity supply undertaking* has determined the voltage level in the *Point of Connection* within the required limits as specified in table 3.1, section 3.1. | Yes  No |
| Within the *normal operating* range, the *typical operating voltage* is *Uc*±10%, see section 47,00, and the frequency range is 52.00 to 52.00 Hz. The *battery plant* can be started and operated continuously within this area, restricted by the protective settings. | Yes  No |
| The plant can withstand transitory (80-100 ms) phase jumps of up to 20 in the *Point of Connection*. | Yes  No |
| The plant can withstand transient frequency gradients of up to 2.5 Hz/s in the *Point of Connection*. | Yes  No |
| After a voltage dip, the plant is able to return to normal operation no later than 5 seconds after the operating conditions have returned to the *normal operating range*. | Yes  No |

* + 1. Voltage dip tolerances

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Will the *battery plant* remain connected to the public electricity supply grid during voltage dips as specified in section 3.3.1, Figure 5? | Yes  No |
| Does the *battery plant* deliver additional reactive current during voltage dips as specified in section 3.3.1, Figure 6? | Yes  No |
| Will the *battery plant* remain connected to the public electricity supply grid during recurring faults as specified in section 3.3.2? | Yes  No |
| Is a simulation enclosed, documenting that the Low Voltage Fault Ride Through (LVFRT) requirements have been met?  If No, how is compliance then documented? | Yes  No |

* + 1. Power quality

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category / Requirements** | **A1** | **A2** | **B** | **C** | **D** |
| DC content (4.2) | X | X | X | X | X |
| Asymmetry (4.3) | X | X | X | X | X |
| Flicker (4.4) | X | X | X | X | X |
| Harmonic distortions (4.5) | X | X | X | X | X |
| Interharmonic distortions (4.6) |  |  | X | X | X |
| Distortions 2-9 kHz (4.7) |  |  | X | X | X |

*Overview of power quality requirements for plant categories*

* + - 1. Voltage quality

For each power quality parameter must be indicated how the result was achieved, either by means of the type test for each of the units of which the *battery plant* is composed, or by means of an emission model developed for the system.

|  |  |
| --- | --- |
| Have the values been calculated/simulated? | Yes  No |
| Have the values been measured? | Yes  No |
| Is a report enclosed, documenting that the calculations or measurements comply with emission requirements?  If No, how are calculations or measurements then documented? | Yes  No |
| Has the *electricity supply undertaking* set emission limits in the *Point of Connection*?  **(Applicable to category C and D *battery plants* for all power quality parameters)**  The requirements for category A1 and A2 *battery plants* are specified in the criteria for inclusion on the *positive list* – for all power quality parameters. The requirements for category B *battery plants* can be found in the regulation. | Yes  No |

* + - 1. DC content

|  |  |
| --- | --- |
| Does the DC content at normal operation exceed 0.5% of the *rated current*? | Yes  No |

* + - 1. Asymmetry

|  |  |
| --- | --- |
| Does asymmetry at normal operation and during faults exceed 16 A? | Yes  No |
| If the *battery plant* consists of single-phase electricity-generating units,  is it ensured that the above limit is not exceeded? | Yes  No |

* + - 1. Flicker

|  |  |
| --- | --- |
| Is the *flicker* contribution for the *battery* plantbelow the limit value?  (See requirements for *category* B *battery plants* in Table 5 in the regulation.) | Yes  No |

* + - 1. Harmonic distortions

|  |  |
| --- | --- |
| Are all *harmonic* *distortions* for the *battery* plantbelow the limit values?  (See requirements for *category* B *battery plants* in Table 6 and Table 7 in the regulation.)  (See requirements for *category* C and D *battery plants* in Table 8 in the regulation.) | Yes  No |

* + - 1. Interharmonic distortions

|  |  |
| --- | --- |
| Are all *interharmonic* *distortions* for the *battery* *plant* below the limit values?  (See requirements for *category* B *battery plants* in Table 10 in the regulation.) | Yes  No |

* + - 1. Distortions in the 2-9 kHz frequency range

|  |  |
| --- | --- |
| Has the requirement for emission of distortions with frequencies in the 2-9 kHz range been met?  (Requirements for *category* B *battery plants*: The emission of currents with frequencies higher than 2 kHz must not exceed 0.2% of the *rated current* in any of the frequency groups measured.) | Yes  No |

* + 1. Control

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Control function | A1 | A2 | B | C | D |
| *Frequency response* – LFSM-O (5.2.1.3) | X | X | X | X | X |
| *Frequency response* – LFSM-U (5.2.1.5) | - | - | - | X | X |
| *Frequency control* | - | - | - | X | X |
| Absolute power limit (5.2.3.1) | X | X | X | X | X |
| *Ramp rate limit* (5.2.3.2) | X | X | X | X | X |
| *Q control* (5.3.1) \*) | X | X | X | X | X |
| *Power Factor control* (5.3.2) \*) | X | X | X | X | X |
| *Automatic Power Factor control* (5.3.4) \*) | X | X | - | - | - |
| *Voltage control* (5.3.3) \*) | - | - | - | X | X |
| System protection (5.4) | - | - | - | (X) | (X) |

*Control functions for a battery.*

All control functions mentioned in the following sections refer to the *Point of Connection.*

In order to ensure security of supply, the *transmission system operator* must be able to activate or deactivate the specified control functions by agreement with the *plant owner.*

Control functions must be for single units or for a plant controller.

Before commissioning, current parameter settings for reactive power and voltage control functions must be determined by the *electricity supply undertaking* in collaboration with the *transmission system operator*.

* + - 1. Connection and synchronisation

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Can the *battery plant* be started and operate continuously within the normal range restricted only by the protective settings? | Yes    No |
| Do connection and synchronisation occur more than 3 minutes after voltage and frequency have come within the normal production range? | Yes    No |

* + - 1. Control of active power and frequency

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery* *plant* equipped with a *frequency response* function?  Regulation must be commenced no later than 2 seconds after a frequency change  is detected and must be completed within 15 seconds.  It must be possible to set the *frequency response* function's frequency points (response frequencies are indicated in Table 11 and Table 12 in the regulation), indicated in Figure 9 and Figure 10 in the regulation, to any value in the 10.00-52.00 Hz range with a resolution of maximum 10 mHz.  For *category* C and D *plants*, *frequency response* functionality is required for underfrequency, LFSM-U. This is required for all *battery plants* in case of overfrequency, LFSM-O. | Yes  No |

* + - 1. Frequency control

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with a *frequency control* function as specified in section 5.2.2? | Yes  No |

* + - 1. Absolute power limit

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with an *absolute power limit* function?  Is the function activated? | Yes  No  Yes  No |

* + - 1. Ramp rate limiter function

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with a *ramp rate limiter* function?  Is the function activated? | Yes  No  Yes  No |

* + - 1. Reactive power control

|  |  |
| --- | --- |
| Reactive power can be controlled by means of: | *Q control*  *Power Factor control*  *Voltage control* |

* + - 1. Q control

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with a *Q control function* as specified in section 5.3.1?  Is the control function activated with a set point of \_\_\_\_\_ VAr?  (Value may not differ from 0 VAr unless agreed with the *electricity supply undertaking*). | Yes  No  Yes  No |

* + - 1. Power Factor control

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with a *Power Factor control* function as specified in section 5.3.2? | Yes  No |

* + - 1. Voltage control

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with a *voltage control* function as specified in section 5.3.3? | Yes  No |

* + - 1. Automatic Power Factor control

**(Applicable to category A1 and A2 battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with an automatic *Power Factor control* function  as specified in section 5.3.4?  As a starting point, the function must be deactivated and must be activated only by agreement with the *electricity supply undertaking*. Is the function deactivated? | Yes  No  Yes  No |

* + - 1. Order of priority for control functions

|  |  |
| --- | --- |
| Has the order of priority for the *battery plant*'s control functions been set as specified in section 5.5? | Yes  No |

* + - 1. System protection

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Is the *battery plant* equipped with a *system protection function* as specified in section 5.4?  Is the function activated? | Yes  No  Yes  No |

* + - 1. Power Factor interval

Control method and settings must be agreed with the *electricity supply undertaking* for *category* C and D *battery plants*.

|  |  |
| --- | --- |
| **Applicable to *plant* *category* A1, A2 and B**  Does the *battery plant* lie within the *Power Factor* interval specified in section 5.3.5.1? | Yes  No |
| **Applicable to *plant category* C**  Does the *battery plant* lie within the *Power Factor* interval specified in section 5.3.5.2, Figure 17?  Can the *battery plant* deliver reactive power in the voltage range as specified in section 5.3.5.2, Figure 18? | Yes  No  Yes  No |
| **Applicable to *plant category* D**  Does the *battery plant* lie within the *Power Factor* interval specified in section 5.3.5.3, Figure 19?  Can the *battery plant* deliver reactive power in the voltage range as specified in section 5.3.5.3, Figure 20? | Yes  No  Yes  No |

* + 1. Protection against electricity system faults

All settings are stated as root-mean-square (RMS) values, and settings deviating from these may be used only with the permission of the *electricity supply undertaking*.

Voltage and frequency must be measured for all three phases as line-to-line voltage.

Alternatively, if the measuring point is located on the low-voltage side of the plant transformer, voltage can be measured between the three phases and ground.

Frequency must be measured simultaneously on all three phases.

* + - 1. Protective functions

|  |  |
| --- | --- |
| **Applicable to *category* A1 and A2 *battery plants***  Are the protective functions with associated operating settings and trip time for the *battery plant* in accordance with the specifications in section 6.3.1, Figure 17? | Yes  No |
| **Applicable to *category* B *battery plants***  Are the protective functions with associated operating settings and trip time for the *battery plant* in accordance with the specifications in section 6.3.2, Figure 18? | Yes  No |
| **Applicable to *category* C *battery plants***  Are the protective functions with associated operating settings and trip time for the *battery plant* in accordance with the specifications in section 6.3.3, Figure 19? | Yes  No |
| **Applicable to *category* D *battery plants***  Are the protective functions with associated operating settings and trip time for the *battery plant* in accordance with the specifications in section 6.3.4? | Yes  No |

* + 1. Exchange of signals and data communication

Activation of the individual functions in the plants and configuration of the specific parameters must fulfil the requirements stated in Technical Regulation 5.8.1 [ref. 10].

* + - 1. Signal description

|  |  |
| --- | --- |
| **Applicable to *category* A1 and A2 *battery plants***  Has the requirement for information exchange with the *battery plant* been met as specified in section 7.2.1, Table 20? | Yes  No |
| **Applicable to *category* B *battery plants***  Has the requirement for information exchange with the *battery plant* been met as specified in section 7.2.2, Table 21? | Yes  No |
| **Applicable to *category* C *battery plants***  Has the requirement for information exchange with the *battery plant* been met as specified in section 7.2.3, Table 22? | Yes  No |
| **Applicable to *category* D *battery plants***  Has the requirement for information exchange with the *battery plant* been met as specified in section 7.2.3, Table 22? | Yes  No |

* + - 1. Fault incident recording and requesting of metered data and documentation

**(Applicable to category D battery plants)**

The specific settings for incident-based logging must be agreed with the *transmission system operator* upon commissioning of the *battery plant*.

|  |  |
| --- | --- |
| Has logging equipment which records voltage for each phase for the *battery plant* been installed in the *Point of Connection*? | Yes  No |
| Has logging equipment which records current for each phase for the *battery plant* been installed in the *Point of Connection*? | Yes  No |
| Has logging equipment which records active power for the *battery plant* (can be computed values) been installed in the *Point of Connection*? | Yes  No |
| Has logging equipment which records reactive power for the *battery plant* (can be computed values) been installed in the *Point of Connection*? | Yes  No |
| Has logging equipment which records frequency for the *battery plant* (can be computed values) been installed in the *Point of Connection*? | Yes  No |
| The *transmission system operator* can request metered data and fault recorder data collected for the *battery plant* for a period of up to three months back in time. | Yes  No |

* + 1. Verification and documentation

The *plant owner* is responsible for ensuring that the *battery plant* complies with this technical regulation and for documenting that requirements are met. A documentation package must be submitted to the *electricity supply undertaking*.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Documentation** | | **A1** | **A2** | **B** | **C** | **D** |
| Supplier statement | X | | X | X | X | X |
| Protective functions | X | | X | X | X | X |
| Single-line representation | X | | X | X | X | X |
| Power quality | X | | X | X | X | X |
| Voltage dip | - | |  | - | X | X |
| PQ diagram | - | |  | - | X | X |
| Signal list | - | |  | - | X | X |
| Dynamic simulation model | - | |  | - | X | X |
| Verification report | - | |  | - | X | X |

*Documentation requirements for plant categories*

* + - 1. Supplier statement

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is a supplier statement regarding the *battery plant* enclosed with the documentation? | Yes  No |

* + - 1. Protective functions

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is documentation of protective functions for the *battery plant* enclosed?  This means a list of values for the relay configurations applicable at the time of verification. | Yes  No |

* + - 1. Single-line representation

**(Applicable to category A1, A2, B, C and D battery plants)**

|  |  |
| --- | --- |
| Is a single-line representation for the *battery plant* enclosed with the documentation?  If No, when will the final single-line representation be provided? | Yes  No |

* + - 1. PQ diagram

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Has the final PQ diagram been submitted to the *electricity supply undertaking*?  If No, when will the final PQ diagram be provided? | Yes  No |

* + - 1. Signal list

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Has the final signal list been submitted to the *electricity supply undertaking*?  If No, when will the final signal list be provided? | Yes  No |

* + - 1. Simulation model

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Has the electrical simulation model for the *battery plant* been submitted to the *electricity supply undertaking*?  If No, when will the final simulation model be provided? | Yes  No |

* + - 1. Verification report

**(Applicable to category C and D battery plants)**

|  |  |
| --- | --- |
| Has the verification report been submitted to the *electricity supply undertaking*?  If No, when will the verification report be provided? | Yes  No |

* + 1. Signature

|  |  |
| --- | --- |
| Date of commissioning |  |
| Company |  |
| Person responsible for  commissioning |  |
| Signature |  |