Guidelines on verification report

Technical regulation 3.2.5
for wind power plants with a power output above 11 kW

REV.	DESCRIPTION	PREPARED	CHECKED	REVIEWED	APPROVED	
0	Published UK edition	12.12.2014	12.12.2014	15.12.2014	15.12.2014	DATE
		KDJ	XLOC	BJA	TSK	NAME
		13/96336-36				

Revision view

Section no.	Text	Revision	Date
	New document, UK edition	0	15.12.2014

Table of contents

Revision view 2

Table of contents 3

Reading instructions 4

1. Terminology, abbreviations and definitions 5

2. Guidelines on the preparation of a verification report 6
   - 2.1 Introduction 6
   - 2.2 Test set-up 6
   - 2.3 Scope of test 6
   - 2.4 Test conditions 6
   - 2.5 Reference documents 6

3. Verification of requirement for control and regulation 7
   - 3.1 Active power control functions 7
   - 3.2 Reactive power control functions 8
   - 3.3 System protection 8

4. Verification of protection requirements 10

5. Verification of data communication requirements 11

Reading instructions

These guidelines describe how to prepare a verification report to demonstrate that a *wind power plant* complies with the technical, functional and documentation requirements with which the relevant *wind power plant* must comply pursuant to Technical regulation 3.2.5 in order to be connected to the grid in Denmark.

The *plant owner* decides which procedure to follow for verification of the *wind power plant's* functionality and set-up. The instructions in these guidelines can be used as a source of inspiration for preparing a specific verification test for *the wind power plant.*

Depending on the category to which the *wind power plant* belongs*,* one or more of the specified tests are not relevant. The specified tests are the maximum number of tests to be carried out for all *wind power plant* categories.

The guidelines are published by Energinet.dk and are available at www.energinet.dk.

1. Terminology, abbreviations and definitions

The general terms, abbreviations and definitions stated in Technical regulation 3.2.5, section 1, are used in this document.

Terms, abbreviations or definitions used in the verification report must be specified in this section.

2. Guidelines on the preparation of a verification report

2.1 Introduction

The verification report must begin with a specification of the overall technical and temporal scope of the verification test.

The verification report must as a minimum include the following:

- Demonstrate through tests that the required control and regulation capabilities have been implemented and function as specified in TR 3.2.5.
- Verify through tests that the exchange of information and data communication properties has been implemented and functions as specified in TR 3.2.5.

The report must indicate the relevant environmental conditions and other conditions for implementing the relevant tests, e.g. temperature, wind speed, wind direction, grid voltage and grid frequency etc.

The duration of each test must be specified.

2.2 Test set-up

This section of the report must include all relevant set-ups, including an outline of the relationship between all major system components together with associated programmes and tools.

In this section, the versions of all components, programmes and tools forming part of the verification test must also be indicated.

2.3 Scope of test

The scope of each verification test must be specified – for instance the test or sub-test selected for verification of a requirement stated in TR 3.2.5.

If sub-tests are mutually dependent, it must be explained how possible impacts from previous tests have been minimised or clarified in the test results.

2.4 Test conditions

The report must include the applicable test conditions at the time of the testing for the respective verification tests. Both internal and external conditions must be specified.

Internal test conditions can include *wind turbine* configuration, grid configuration, primary and secondary grid set-ups and state of maintenance etc.

External conditions may include wind speed, wind direction, turbulence level, grid voltage and grid frequency etc.

2.5 Reference documents

This section must include all documents which form the basis of the verification, or which are used during the test.

3. Verification of requirement for control and regulation

R5.1	If a *plant* has been disconnected due to a failure in the *public electricity supply grid*, the *plant* must at the earliest connect automatically three minutes after the voltage and frequency once again lie within the *normal production area*.	Demonstrate through tests that the *plant* connects as specified.
R5.2	A *plant* which has been disconnected by an external signal prior to a failure occurring in the *public electricity supply grid* must not be connected until the external signal has been eliminated, and the voltage and frequency once again lie within the *normal production area*.	Demonstrate through tests that the *plant* connects as specified.
R5.3	All set point changes and orders must be registered together with an identification of the operator.	Demonstrate that all recordings are performed as specified.
R5.4	All set point changes or orders for production changes must be time stamped.	Demonstrate that all recordings are performed as specified.

3.1 Active power control functions

R5.5	In case of frequency deviations in the *public electricity supply grid*, the *plant* must be able to provide *frequency control* in order to stabilise the grid frequency (50.00 Hz).	Document that the *plant* is capable of meeting the functionality requirements.
R5.6	All frequency point settings must be indicated with a minimum resolution.	Document that the *plant* is capable of meeting the resolution requirements.
R5.7	Accuracy of grid frequency measurements	Document that the *plant* is capable of meeting the requirements for frequency measurement accuracy.
R5.8	It must be possible to set the *frequency control* function for all frequency points as specified.	Document that the *plant* is capable of meeting the set-up requirements.
R5.9	In case of grid frequencies above f_5, upward regulation must not be commenced until the grid frequency is lower than f_7.	Demonstrate through tests that the *plant* is capable of meeting the control requirements.
R5.10	It must be possible to activate the *frequency control* function in the f_{min} to f_{max} range.	Document that the *plant* is capable of meeting the requirements for dynamic range.
R5.11	The *plant* must be capable of continuously regulating the active power to a random value in the interval from 100% to at least xx% of the *rated power*. The adjustment range depends on the *plant* category.	Demonstrate through tests that the *plant* is capable of meeting the function requirements.
R5.12	The *plant* must stay connected to the *public electricity supply grid* at mean wind speeds below a predefined *cut-out wind speed*. As	Document that the *plant* is capable of meeting the function requirements.

	regards *wind speeds* in the proximity of the *cut-out wind speed*, the *plant* must be able to downward regulate the active power as specified. When downward regulation is performed, the shutting-down of individual *wind turbines* is allowed to ensure that the regulation characteristics are followed in the best possible way.	
R5.13	An *absolute production constraint* is used to constrain the active power from a *plant* to a predefined power limit in the *point of connection*.	Demonstrate through tests that the *plant* is capable of meeting the requirements for the control constraint function.
R5.14	A *delta production constraint* is used to constrain the active power from a *plant* to a required constant value in proportion to the possible active power.	Demonstrate through tests that the *plant* is capable of meeting the requirements for the control constraint function.
R5.15	A *ramp rate power constraint* is used to limit the maximum speed by which the reactive power changes in the event of changes in wind speed or the set points for a *plant*.	Demonstrate through tests that the *plant* is capable of meeting the requirements for the control constraint function.

3.2 Reactive power control functions

R5.16	*Q control* is a control function ensuring that reactive power is supplied continuously and independently of the active power in the *point of connection*.	Demonstrate through tests that the *plant* is capable of meeting the *Q co*ntrol requirements.
R5.17	*Power factor* control is a control function that ensures variable reactive power in proportion to the active power in the *point of connection*.	Demonstrate through tests that the *plant* is capable of meeting the *power factor* control requirements.
R5.18	*Voltage control* is a control function that stabilises the voltage in the *voltage reference point*.	Demonstrate through tests that the *plant* is capable of meeting the *voltage control* requirements.
R5.19	It must be possible to set the *voltage control droop* within the 2-8% range.	Document that the *plant* is capable of meeting the setting requirements.
R5.20	When the *voltage control* is adjusted to the *plant's* dynamic planning limits, the control function must await possible overall control from the tap changer or other *voltage control functions*.	Demonstrate through tests that the *plant* is capable of meeting the *voltage control* requirements.

3.3 System protection

R5.21	A *plant* must be equipped with system protection – a control function which must be capable of automatically downward regulating	Demonstrate through tests that the *plant* is capable of meeting the function requirements.

	the active power supplied by a *plant* to one or more predefined set points. The number and value of the set points are determined by the *grid company* upon commissioning.	
R5.22	Control following activation must be commenced as quickly as technically possible.	Demonstrate the *plant's* properties through tests.

4. Verification of protection requirements

R6.1	Protective functions with associated operating settings and trip time must be as indicated in the relevant sections in TR 3.2.5.	Relay set-ups at the time of commissioning must be stated in the documentation.

5. Verification of data communication requirements

R7.1	The *plant* must be prepared for receiving an external start signal (released) and an external stop signal. The signals must be accessible via commands in accordance with the specifications.	Demonstrate through tests that the *plant* is capable of meeting the function requirements.
R7.2	It must be possible to obtain correct measurements and maintain data communication in all situations, including when *plants* are shut down and the grid is dead. Local back-up supply must as a minimum ensure the logging of relevant measurements and data and ensure the controlled shut-down of the *plant's* control and monitoring system.	Demonstrate through tests that the *plant* is capable of meeting the function requirements.
R7.3	All measurements and data relevant to recording and analysis must be logged with a time stamp and an accuracy ensuring that such measurements and data can be correlated with each other and with similar recordings in the *public electricity supply grid*.	Demonstrate through tests that the *plant* is capable of meeting the requirements.
R7.4	For a *plant*, the information exchange must as a minimum be implemented using a protocol stack in accordance with IEC 61400-25-4 with mapping to IEC-60870-5-104. The protocol stack must be implemented with support for two masters as a minimum.	Demonstrate through tests that the *plant* is capable of meeting the requirements.
R7.5	The specific requirements for information and signals must be documented in the *PCOM* interface.	Document that the *plant* is capable of meeting the requirements. A complete signal list may be enclosed.