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Australian Energy Market Commission
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Project Reference Code: ERC0222
Submission to the Rule Change Proposal of Generator Technical Performance Standards

Dear Sir or Madam,

With regard to the rule change request from AEMO on 11 August 2017, Nordex (wind turbine manufacturer) is commentting on the issues raised by the rule change request and is providing hereby written submissions to a few questions asked by the Australian Energy Market Commission.

Australian Energy Market Commission:

Question 1 Assessment framework

Do you agree with the Commission's proposed approach to assessing whether the rule change request will, or is likely to, contribute to the achievement of the national electricity objective? If not, how should it be assessed?

Answer from Nordex:

It is important to understand the characteristics and limitations of each technology to ensure technology neutrality and to avoid discrimination of specific types of technology.
Each system has its own advantages as well as disadvantages. To assure power system stability and to avoid raising costs, the strengths of each system should be taken into account and used in the best possible manner. As the characteristics of each technology vary, it doesn't seem to be appropriate to require the same behaviour for each type of technology.

Australian Energy Market Commission:

Question 3 Proposed changes to generator access standards

For each of AEMO's technical recommendations set out in Appendix B:

- **Do you agree with AEMO's analysis of the issue in relation to the proposed change to the access standard?**
- **Would the proposed change address the issue raised by AEMO? If not, what alternative solutions are there?**
- **Does the proposed change represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**
- **Can you provide an indication of the costs associated with the proposed change?**

Answer from Nordex:

Comparing the proposed access standard by AEMO with other international standards, the proposal can be assessed as one of the most challenging grid codes worldwide. The proposal has definitely the hardest fault ride through (FRT) requirements known so far. Especially the multiple fault ride through (MFRT) requirements in combination with the active power recovery ramp rates as well as the reactive current requirements are more than challenging and are not always focusing on the different types of technologies.

This will be explained in more detail in the following.

The new grid code proposal set out the following multiple fault ride through requirements:

Multiple low voltage disturbance withstand	*Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **automatic access standard** – AEMO proposes the following new requirement for generators to withstand multiple low voltage disturbances under the automatic access standard: • a generating system and each of its generating units and reactive plant must maintain in continuous uninterrupted operation for up to 15 voltage disturbances in any 5-minute period and that the total time that the voltage at the connection point is less than 90% of normal voltage is 1,800ms.
	Clause S5.2.5.5 Generating system response to disturbances following contingency events – **minimum access standard** – AEMO proposes new requirements covering multiple low voltage disturbances withstand under the minimum access standard. AEMO proposes minimum access standard requirements that mirror those of the automatic access standard except that it requires a total withstand period of 1,000ms (rather than 1,800ms): • a generating system and each of its generating units and reactive plant must maintain continuous uninterrupted operation for up to 15 voltage disturbances in any 5-minute period and that the total time that the voltage at the connection point is less than 90% of normal voltage is 1,000ms.

Focusing on wind turbines (WT), this requirement seems to take into account full converter WTs, only. Apparently, the challenge to ride through 15 FRTs within any 5 minutes period shall be limited by the total time requirement of 1800ms (Automatic Access Standard), 1000 ms (Minimum Accesss Standard), respectively. This is not helping for a WT with a double-fed induction generator (DFIG) system.

A WT with a full converter system will usually activate the chopper during the whole FRT to reduce the active power output and therefore its multiple fault ride through capability will be limited by the chopper design.
As the WT with a DFIG system is directly connected via the stator-side to the grid, a voltage dip has an influence on the loads of the wind turbine (especially on the drive train and the tower). Here, the stress for the loads is depending on the remaining torque/reduction of active power output. Due to each low voltage ride through (LVRT) event, mechanical oscillations arise. These mechanical oscillation will be increased by MFRTs (swinging up of oscillations).

Therefore, the advantages and limitations of a DFIG system are different to a WT with a full converter system. The stress for the loads is higher for a DFIG system, but the DFIG system doesn't need to chopper during the whole time of the FRT event and is less limited by the chopper design compared to the full converter system. The chopper of a DFIG system will mainly be stressed in the first mains period of the fault, only. Therefore, a well-designed DFIG system will usually be limited by the loads and not by the chopper design.

Considering the stress for the loads, the type of fault as well as the time between each fault occurrence and the ramp rate for active power recovery are important influence factors and determine the multiple fault ride through capability of a DFIG WT.

In the following a suggestion for adapting the requirement of the grid code proposal is made. The changes are listed in bold and are underlined:

S5.2.5.5 Generating system response to disturbances following contingency events.

(1) a *generating system* and each of its *generating units* must remain in *continuous uninterrupted operation* for up to fifteen disturbances within any five-minute period, **but limited to**

- **2 faults within 15 s in case of symmetrical faults**
- **3 faults within 15 s in case of a two-phase fault**
- **4 faults within 15 s in case of a one-phase fault**

caused by any combination of the following events: ...

With the made suggestion above, the fault ride through events from 28th of September 2016 would have been withstand and successfully ridden through.

Focusing on the reactive current requirements proposed by AEMO, Nordex would like to suggest the following adaptation to the grid code proposal:

General requirement

(i)

(iv) the reactive current response must have a *rise time* of no greater than 30 milliseconds, a *settling time* of no greater than 60 milliseconds and must be *adequately damped*; **the times for reactive current response start after 20 milliseconds, this time is needed for detecting the fault**

Without this additional time of 20 ms for detecting the fault, the times for controlling the reactive current will be reduced to a rise time of 10 ms and a settling time of 40 ms. Other grid codes with the same proposed requirements of 30 ms and 60 ms respectively, have additional guidelines how to evaluate these requirements (e.g. in Germany there is a technical guideline called "TG 8 – Certification of the Electrical Characteristics of Power Generating Units and Systems in Low-, Medium-, High- and Extra-High Voltage Grids"; http://www.wind-fgw.de/shop/technical-guidelines/?lang=en). These guidelines are also focusing on the time which is needed for detecting the fault and are adding another 20 ms as a dead-time to the original grid code requirement.

Furthermore, Nordex would like to ask for an adaptation of the definition of settling time for FRTs and suggests the following:

settling time

In case of reactive current response due to a system disturbance, the time measured from initiation of a step change in an input quantity to the time when the magnitude of error between the output quantity and its final settling value remains less than

(1) – 10 % of the maximum continuous current of the generating system from its final settling value
(2) + 20 % of the maximum continuous current of the generating system from its final settling value

This change is needed to fulfil the settling times also for deep voltage dips down to 0 % of nominal voltage. In Germany, the settling times for deep voltage dips down to a residual voltage below 10 % of nominal voltage (for asymmetrical and symmetrical faults) are actually excluded from the evaluation. Especially for deep symmetrical voltage dips, it is hard to get the correct reference value for reactive and active current as the phase angle can't be determined during the deep voltage dips.

Focusing on the requirements for voltage and reactive power control, Nordex would like to suggest an adaptation of the direct voltage control requirements as listed below:

S5.2.5.13 Voltage and reactive power control

Automatic access standard

(2A) all *generating systems* must have a *voltage control system* that:

(i) regulates *voltage* at the *connection point* or another agreed location in the *power system* (including within the *generating system*) to within 0.5% of the setpoint; **the generating system doesn't need to exceed the reactive power capability required in S5.2.5.1**

Minimum access standard

(3) the *voltage control system* for a *generating system* must:

(i) regulate *voltage* at the *connection point,* or at another agreed location on the *power system* or within the *generating system,* to within 2% of the setpoint; **the generating system doesn't need to exceed the reactive power capability required in S5.2.5.1**

This adaptation is needed as the influence of the generating system to the voltage is depending on the grid characteristics. Even with feeding in the maximum possible reactive power, the generating system might not be able to influence the voltage as much as required due to the system strength.

Nordex assumes that the required voltage control must be performed with a direct voltage control (e.g. direct PI-Control) and not a voltage dependent reactive power control (e.g. slope/droop control).
For a voltage control with slope or droop, the accuracy requirement must be related to the resulting reactive power response and not to a given voltage set point. A voltage control with a voltage dependent reactive power control is seldom able to regulate the voltage to a given voltage set point as it is only reacting to voltage deviations.

Australian Energy Market Commission:

Question 4 System strength access standard

- **Do you agree with AEMO's analysis of the issue related to system strength?**
- **Would the proposed changes address these issues, particularly in light of the Commission's *Managing system fault levels rule change final determination*? If not, what alternative solutions are there?**

- **Would the proposed changes relating to system strength represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**

Answer from Nordex:

In general, wind turbines and wind farms can operate at a short circuit ratio of 3.0. Nevertheless, there are fundamental physical limits, independent from the technology type used, to the operating range of a wind farm that could occur at a SCR of 3. To avoid stability issues, it is important that the system operator does not require the operation of a wind farm at its physical limits (e.g. there shouldn't be any grid code requirements of consuming reactive power if the voltage is already low or injecting active power up to angle stability limits).

For analysing and evaluation of system stability, a maximum variation of the short circuit ratio across a short time-frame should be specified project specifically by the system operator.
In case that there are significant changes in the short circuit ratio due to future changes of the grid, the system operator should notify the generators and specify the new range of minimum and maximum short circuit ratios.

Nordex would like to thank you in advance for considering the suggestions above. Please, don't hesitate to contact us in case of any questions and please keep us informed about updates regarding the rule change request.

Yours sincerely,

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