TRANSFER OF PERFORMANCE REQUIREMENTS FROM COMPLIANCE PROCESS TO GRID CODE

Paper by National Grid

Introduction

1. This paper outlines the technical performances expected of generating plant that have been assumed as part of the compliance process which should be properly included within the Grid Code to allow industry scrutiny.

Background

2. The industry, through the GCRP expressed concern that National Grid was applying performance criteria in Compliance Guidance that was not being explicitly called for in the Grid Code and Bilateral Connection Agreements. To address this concern National Grid have proposed a Working Group to look at the whole "Compliance Issue" including the process, the relationship with OC5 and the technical performance requirements. This paper contains the technical plant issues that National Grid expected to be met and which were highlighted in the Compliance Guidance but are not currently explicitly in the Grid Code. The Grid Code changes proposed below have come to light following the publication of the G/06 consultation and the release of greatly enhanced draft guidance documents to compliment.

Glossary and Definitions

1. The consultation G06 included a change to CC.6.3.7 (c)(ii) to improve the interpretation of droop in wind farms. A similar change is recommended to the Droop definition in the G&D section of the Grid Code as shown in Appendix A of this paper.

Planning Code

2. The Planning Code requires the submission of control system models for both synchronous and non-synchronous generation to allow National Grid to simulate system behavior to ensure stable operation. Obviously the control system models should represent the behavior of the real generation plant. While the changes made by H/04 partially addressed the need for the models to be validated for Power Park Modules, the drafting was not as explicit as it could have been and the requirement was not extended to traditional synchronous generation. National Grid proposes to address these by alteration to the Planning Code text. See Appendix B.

Power System Stabiliser

3. The changes consulted on under G/06 transferred the majority of the requirements for excitation systems from Bilateral Agreements into the Grid Code. The compliance process guidance notes had additional clarifications on excitation systems that it is now proposed to include in the Grid Code.

4. It has been noted that the wording limiting the magnitude of the Power System Stabiliser output could be misconstrued, so a minor change to CC.A.6.2.5.4 is proposed.

5. The wording of BC2.11.2 states that the Power System Stabiliser should be left in service once commissioned. However it might be construed that the Power System Stabiliser may be automatically disabled by the functions within the excitation system such as the Under Excitation Limiter. While these limiter functions may curtail the excitation system output, the Power System Stabiliser and Automatic Voltage Regulator

should still be active.

6. There is also the potential for confusion when a Generating Unit is operating as a motor as in a Pumped Storage Power Station. National Grid would like to clarify this by adding to the text proposed in G/06 for CC.A.6.2.5.8.

7. With modern governor systems some Generating Units, notably Pumped Storage are able to execute very fast changes in mechanical power. A Power System Stabiliser may try to counteract this mechanical power change by altering the excitation phasing producing large swings in reactive output. This is undesirable for stable voltage control and it is therefore proposed to include an additional clause in CC.A.6.2.5.3.

8. Draft wording for these Power System Stabiliser issues can be found in Appendix C.

Operation above 50.5Hz

9. For Frequency Sensitive Mode (FSM), generating units are required to provide response in accordance with the frequency response matrix values agreed in the Mandatory Services Agreement. The High Frequency Response level in the agreement is limited to 50.5Hz. However, if the frequency continues to rise above 50.5 Hz, BC3.7.1(c) requires stations to continue to reduce their output.

10. This continual reduction capability is critical to system security as the system frequency at this time would already be above its statutory limit indicating the system is already under stress. It is imperative that all generating stations including those not in frequency sensitive mode are required to reduce in output to contain the system frequency rise. This condition if not controlled could lead to the frequency being driven above 52 Hz and the collapse of the system.

11. National Grid believes that the requirement in BC3.7.1(c) should be improved by incorporating a more detail breakdown of the power reduction process as that adopted in BC3.7.2 for the Limited Frequency Sensitive Mode (LFSM) operation. A draft showing how BC.3.7.1(c) would look is included in Appendix D.

Recommendations

12. The Working Group is asked to consider the proposed changes detailed below to allow discussion at the first group meeting on 15 January 2008.

Appendix A

Droop definition clarification (Glossary and Definitions)

Droop	The ratio of the steady state change in speed in the case of a **Generating Unit,** or in **Frequency** in the case of a **Power Park Unit,** to the steady state change in power output of the **Generating Unit** or **Power Park Unit.** For the avoidance of doubt, in the case of a **Power Park Module** the speed **Droop** should be the equivalent of a fixed setting between 3% and 5% applied to each **Power Park Unit** in service.

Appendix B

PC.A.5.3.2 …….

(c) Excitation Control System parameters

Note: The data items requested under Option 1 below may continue to be provided in relation to **Generating Units** on the **System** at 09 January 1995 (in this paragraph, the "relevant date") or the new data items set out under Option 2 may be provided. **Generators** or **Network Operators**, as the case may be, must supply the data as set out under Option 2 (and not those under Option 1) for **Generating Unit** excitation control systems commissioned after the relevant date, those **Generating Unit** excitation control systems recommissioned for any reason such as refurbishment after the relevant date and **Generating Unit** excitation control systems where, as a result of testing or other process, the **Generator** or **Network Operator**, as the case may be, is aware of the data items listed under Option 2 in relation to that **Generating Unit**. For **Generating Unit** excitation control systems commissioned or recommissioned after 1 January 2009, the model described by the submitted transfer block diagrams should be validated against test results.

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(d) Governor Parameters

Incremental Droop values (in %) are required for each **Generating Unit** at six MW loading points (MLP1 to MLP6) as detailed in PC.A.5.5.1 (this data item needs only be provided for **Large Power Stations**)

Note: The data items requested under Option 1 below may continue to be provided by **Generators** in relation to **Generating Units** on the **System** at 09 January 1995 (in this paragraph, the "relevant date") or they may provide the new data items set out under Option 2. **Generators** must supply the data as set out under Option 2 (and not those under Option 1) for **Generating Unit** governor control systems commissioned after the relevant date, those **Generating Unit** governor control systems recommissioned for any reason such as refurbishment after the relevant date and **Generating Unit** governor control systems where, as a result of testing or other process, the **Generator** is aware of the data items listed under Option 2 in relation to that **Generating Unit**. For **Generating Unit** governor control systems commissioned or recommissioned after 1 January 2009, the model described by the submitted transfer block diagrams should be validated against test results.

PC.A.5.4.2 The following **Power Park Unit, Power Park Module** and **Power Station** data should be supplied in the case of a **Power Park Module** not connected to the **Total System** by a **DC Converter**:

(a) **Power Park Unit** model

A mathematical model of each type of **Power Park Unit** capable of representing its transient and dynamic behavior under both small and large disturbance conditions. The model shall include non-linear effects and represent all equipment relevant to the dynamic performance of the **Power Park Unit** as agreed with **NGET**. The model shall be suitable for the study of balanced, root mean square, positive phase sequence time-domain behaviour, excluding the effects of electromagnetic transients, harmonic and sub-harmonic frequencies.

The model shall accurately represent the overall performance of the **Power Park Unit** over its entire operating range including that which is inherent to the **Power Park Unit** and that which is achieved by use of supplementary control systems providing either continuous or stepwise control. Model resolution should be sufficient to accurately represent **Power Park Unit** behaviour both in response to operation of transmission system protection and in the context of longer-term simulations.

The overall structure of the model shall include:

(i) any supplementary control signal modules not covered by (c), (d) and (e) below.

(ii) any blocking, deblocking and protective trip features that are part of the **Power Park Unit** (e.g. “crowbar”).

(iii) any other information required to model the **Power Park Unit** behaviour to meet the model functional requirement described above.

The model shall be submitted in the form of a transfer function block diagram and may be accompanied by dynamic and algebraic equations. This model shall display all the transfer functions and their parameter values, any non wind-up logic, signal limits and non-linearities.

The submitted **Power Park Unit** model and the supplementary control signal module models covered by (c),(d) and (e) below shall have been validated and this shall be confirmed by the **Generator**. The validation shall be based on comparing the submitted model simulation results against measured test results. Validation evidence shall also be submitted and this shall include the simulation and measured test results. The latter shall include appropriate short-circuit tests. In the case of an **Embedded Medium Power Station** not subject to a **Bilateral Agreement** the **Network Operator** will provide **NGET** with the validation evidence if requested by **NGET**.

(b) **Power Park Unit** parameters

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Appendix C

CC.A.6.2.5.3 The arrangements for the supplementary control signal shall ensure that the **Power System Stabiliser** output signal relates only to changes in the supplementary control signal and not the steady state level of the signal. For example, if generator electrical power output is chosen as a supplementary control signal then the **Power System Stabiliser** output should relate only to changes in generator electrical power output and not the steady state level of power output. Additionally **the Power System Stabiliser** should not react to mechanical power changes for example during operator dispatched changes in steady state load or when providing frequency response.

CC.A.6.2.5.4 The output signal from the **Power System Stabiliser** shall be limited to not more than ±10% of the **Generating Unit** terminal voltage signal at the **Automatic Voltage Regulator** input. The gain of the **Power System Stabiliser** shall be such that an increase in the gain by a factor of 3 shall not cause instability.

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CC.A.6.2.5.6 The **Generator** will agree **Power System Stabiliser** settings with **NGET** prior to the on-load commissioning detailed in BC2.11.2(d). To allow assessment of the performance before on-load commissioning the **Generator** will provide to **NGET** a report containing:

i. the **Excitation System** model including the **Power System Stabiliser** with settings as required under the **Planning Code** (PC.A.5.3.2(c)).
ii. on load time series simulations of the response of the **Excitation System** with and without the **Power System Stabiliser** to 2% and 10% steps in the reference voltage and a three phase short circuit fault applied to the higher voltage side of the **Generating Unit** transformer for 100 ms. The results should show field voltage, **Generating Unit** terminal voltage, **Power System Stabiliser** output and **Generating Unit Active Power** and **Reactive Power** output.
iii. gain and phase Bode diagrams for the open loop frequency domain response of the **Generating Unit Excitation System** with and without the **Power System Stabiliser**, operating under maximum leading conditions and minimum fault level conditions as agreed with **NGET**. These should be in a format to allow assessment of the phase contribution of the **Power System Stabiliser** and the gain and phase margin of the **Excitation System** with the **Power System Stabiliser**

CC.A.6.2.5.7 The **Power System Stabiliser** must be active within the **Excitation System** at all times and must not be disabled when the **Under excitation Limiter** or **Over-excitation Limiter** are active. When **Synchronising** or **De-Synchronising** a **Generating Unit** the **Power System Stabiliser** may be out of service but the activation and the de-activation of the **Power System Stabiliser** shall be part of the run-up and run-down sequence respectively.

CC.A.6.2.5.8 Where a **Power System Stabiliser** is fitted to a **Pumped Storage Unit** it must function when the **Pumped Storage Unit** is in both generating and pumping modes.

Appendix D

BC3.7.1 Plant in Frequency Sensitive Mode instructed to provide High Frequency Response

(c) In addition to the High Frequency Response provided, the Genset (or DC Converter at a DC Converter Station) must continue to reduce Active Power output in response to an increase in System Frequency ~~up to~~ above 50.5 Hz as provided in (i) to (v) below. ~~or above at a minimum rate of 2 per cent of output per 0.1 Hz deviation of System Frequency above that level, such reduction to be achieved within five minutes of the rise to or above 50.5 Hz.~~ For the avoidance of doubt, the provision of this reduction in Active Power output is not an Ancillary Service.

(i) The rate of change of Active Power output must be at a minimum rate of 2 per cent of output per 0.1 Hz deviation of System Frequency above 50.5 Hz.

(ii) The reduction in Active Power output must be continuously and linearly proportional as far as practical, to the excess of Frequency above 50.5 Hz and must be provided increasingly with time over the period specified in (iii) below.

(iii) As much as possible of the proportional reduction in Active Power output must result from the frequency control device (or speed governor) action and must be achieved within 10 seconds of the time of the Frequency increase above 50.5 Hz.

(iv) The residue of the proportional reduction in Active Power output which results from automatic action of the Genset (or DC Converter at a DC Converter Station) output control devices other than the frequency control devices (or speed governors) must be achieved within 3 minutes from the time of the Frequency increase above 50.5 Hz.

(v) Any further residue of the proportional reduction which results from non-automatic action initiated by the Generator or DC Converter Station owner shall be initiated within 2 minutes, and achieved within 5 minutes, of the time of the Frequency increase above 50.5 Hz.