CLARIFICATION OF GRID CODE FREQUENCY RESPONSE REQUIREMENTS
Paper by National Grid

Introduction

1. During recent discussions with Generators on frequency response performance of wind farms, suggestions were made by Generators that the minimum frequency response performance requirement of a generating unit, in particular during the initial response period, should be clarified in the Grid Code.

2. This issue was discussed at the Power Park Modules and Synchronous Generating Units Working Group (PPMSGUWG) and a proposal was made in the Working Group Report and G/06 Consultation Document dated 14 December 2006. The nature of the proposal was to clarify the Grid Code requirements.

3. The main part of the proposal to improve the clarity of requirements was to include some of the existing wordings in the Glossary and Definitions for Primary and High Frequency responses in CC.A.3.4 where the response profile is specified.

4. For the initial response following the start of the frequency change, an inherent delay with any type of generating plant has always been recognized but appropriate control measures help to minimize any avoidable delay. This has been successfully adopted by the industry in the past and NGET believed that no further clarification of maximum allowable delay was considered to be necessary.

5. However, a recent tripartite meeting between a developer, NGET and OFGEM held on 5 March 2007 resulted in a review of this position. This paper provides a background to the issue and proposes possible ways forward.

Background

6. With the current Grid code wordings, the industry has successfully designed generating plant to minimize the initial time delay following a 10 second ramp frequency injection to generally less than two seconds. This has also been achieved by recently tested Power Park Modules.

7. However at one PPM site, an initial delay of over 5 seconds was observed which NGET believes is not the result of any inherent delays in wind turbine dynamic behaviour but due to the choice of control settings adopted. In fact, the dynamic response of some wind turbines can have negligible delay as indicated from some recent test results.

8. As reflected in the Grid Code, generating plant response characteristics for the period of 0 to 10 seconds are critical in limiting maximum frequency excursions. A maximum frequency dip following a large generation loss could occur within 10 seconds and any unnecessary delay of response from frequency sensitive generation within this period could result in unnecessary customer demand disconnections and blackouts.

9. The earlier that the response is delivered by generators within the 0 to 10 seconds time scale, the lower is the risk of the system frequency being driven outside its acceptable limits leading to possible demand disconnections. For this reason, the existing wordings '… *Active Power output to be released increasingly with time over the period of 0 to 10 seconds* …' have been adopted in the Primary and High Frequency Responses in the G & D section of the Grid Code. This message is also enhanced diagrammatically in Figures CC.A.3.2 and CC.A.3.3 in the Appendix 3 of the Grid Code.

10. Whilst NGET believed that the initial response requirement has been clearly stated in the Grid Code, NGET agreed to include a similar statement in the CC.A.3.4 as recommended in the G06 Consultation Document to aid visibility.

11. Following the recent meeting with OFGEM and a developer, there appeared to be a need to consider if a further clarification in the Grid Code is required in relation to the inclusion of a minimum time delay for plant response as initiated by an injection of a 10-second ramp simulated frequency change.

Options

Option 1- No further Grid Code changes required

12. This option recognises that the Grid Code wording together with that proposed in the G06 Consultation Document is adequate to communicate with developers and their plant suppliers that the initial response is of significant importance to system security. On this basis, they will ensure appropriate control measures to minimize any avoidable time delays in the plant response. This has been successfully adopted by the industry in the past including wind farms.

13. This approach gives some flexibility to plant designers should there be any genuine inherent plant delay which is absolutely unavoidable. From our past experience and some wind farm test records, NGET believes PPMs are capable of reducing any initial avoidable delays to those achieved by other plant types.

14. This option might not be considered to provide the additional clarity and might still result in a future debate on this issue as indicated in the recent OFGEM/Developer/NGET meeting. However, the Generator Guidance Document issued in February 2007 gives an indicative maximum time delay of 2 seconds.

Option 2- Include a maximum time delay requirement in the Grid Code

15. An alternative is to include a maximum time delay requirement in the Grid Code to provide further clarity. Based on NGET's experience and the need to contain the adverse impact on system frequency stability, the maximum delay requirement may be up to two seconds. The effect of such a delay in terms of the increase in the risk of system frequency being driven outside secure limits, possibly leading to unnecessary demand disconnections and blackouts, need to be evaluated.

16. A requirement that permits two seconds initial response time delay on a generic basis for all future plant may be unnecessary for many plant that inherently responds with insignificant initial delay.

Option 3- Include an indicative allowable time delay in the Grid Code

17. This option builds on the issues discussed in options 1 and 2 above. It proposes introducing additional clarity to the existing Grid Code wording and that proposed in G06 consultation document. It codifies existing practice that ensures that plant control systems are designed to reduce any avoidable initial delay to a minimum as far as is reasonably practicable and in any event to less than two seconds. It also recognizes that there might be a longer unavoidable time delay.

18. Given the system security considerations, NGET believes, from past experience, that most generating plant if designed correctly will have insignificant initial delay.

19. In view of the above, NGET recommends Option 3. For the G06 consultation, NGET is addressing the responses received and is in the process of preparing a report to the Authority. The opportunity could be taken to incorporate the relevant clarifications as shown in Attachment A of this paper to the above report. Alternatively, a new consultation on the subject of this paper will need to be issued.

Other aspects of frequency response profile

20. Based on discussions with some Generators, the profile of the frequency response over the period 0 to 10 seconds also needs clarification in wording in addition to the profile shown in Figure CC.A.3.2.

21. NGET proposes that this is clarified by inserting the words “at least linearly” in both CC.A.3.4 and the Glossary and Definitions as shown in the attached legal text.

Recommendations

22. The GCRP is invited to:

a) note the implications of excessive initial frequency response delay on system security

b) discuss the various options for clarifying the frequency response requirements

c) agree this clarification as proposed in Option3 can be incorporated into the G06 report to the Authority or issued as a new separate consultation.

ATTACHMENT A – Proposed Legal Text Changes for Option 3

[Key to the changes:

Black – existing Grid Code text
Red – proposed in G06 Consultation Document
Blue – proposed wordings for Option 3 recommended in this paper]

APPENDIX 3

MINIMUM FREQUENCY RESPONSE REQUIREMENT PROFILE AND OPERATING RANGE
for new Power Stations and DC Converter Stations.

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CC.A.3.4 TESTING OF FREQUENCY RESPONSE CAPABILITY

The response capabilities shown diagrammatically in Figure CC.A.3.1 are measured by taking the responses as obtained from some of the dynamic response tests specified by **NGET** and carried out by **Generators** and **DC Converter Station** owners for compliance purposes and to validate the content of **Ancillary Services Agreements** using an injection of a **Frequency** change to the plant control system (i.e. governor and load controller). The injected signal is a linear ramp from zero to 0.5 Hz **Frequency** change over a 10-second period, and is sustained at 0.5 Hz **Frequency** change thereafter, as illustrated diagrammatically in figures CC.A.3.2 and CC.A.3.3. In the case of an **Embedded Medium Power Station** not subject to a **Bilateral Agreement** or **Embedded DC Converter Station** not subject to a **Bilateral Agreement**, **NGET** may require the **Network Operator** within whose **System** the **Embedded Medium Power Station** or **Embedded DC Converter Station** is situated, to ensure that the **Embedded Person** performs the dynamic response tests reasonably required by NGET in order to demonstrate compliance within the relevant requirements in the **CC**s.

The **Primary Response** capability (P) of a **Generating Unit** or a **CCGT Module** or **Power Park Module** or **DC Converter** is the minimum increase in **Active Power** output between 10 and 30 seconds after the start of the ramp injection as illustrated diagrammatically in Figure CC.A.3.2. This increase in **Active Power** output should be released at least linearly with time over the period 0 to 10 seconds from the time of the start of the **Frequency** fall as illustrated by the Plant Response in Figure CC.A.3.2. If there is an initial inherent delay in the increase of **Active Power** output following a **Frequency** fall, this must be minimised as far as is reasonably practicable and in any event such a delay should be no longer than two seconds unless in NGET's reasonable opinion a longer delay is unavoidable.

Comment [w1]: 'increasingly' deleted

The **Secondary Response** capability (S) of a **Generating Unit** or a **CCGT Module** or **Power Park Module** or **DC Converter** is the minimum increase in **Active Power** output between 30 seconds and 30 minutes after the start of the ramp injection as illustrated diagrammatically in Figure CC.A.3.2.

The **High Frequency Response** capability (H) of a **Generating Unit** or a **CCGT Module** or **Power Park Module** or **DC Converter** is the decrease in **Active Power** output provided 10 seconds after the start of the ramp injection and sustained

thereafter as illustrated diagrammatically in Figure CC.A.3.3. This reduction in **Active Power** output should be released at least linearly with time over the period 0 to 10 seconds from the time of the start of the **Frequency** rise as illustrated by the Plant Response in Figure CC.A.3.2. If there is an initial inherent delay in the reduction of **Active Power** output following a **Frequency** rise, this must be minimised as far as is reasonably practicable and in any event such a delay should be no longer than two seconds unless in NGET's reasonable opinion a longer delay is unavoidable.

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Glossary & Definitions *[associated changes]*

High Frequency Response

An automatic reduction in **Active Power** output in response to an increase in **System Frequency** above the **Target Frequency** (or such other level of **Frequency** as may have been agreed in an **Ancillary Services Agreement**). This reduction in **Active Power** output must be in accordance with the provisions of the relevant **Ancillary Services Agreement** which will provide that it will be released at least linearly with time over the period 0 to 10 seconds from the time of the **Frequency** increase on the basis set out in the **Ancillary Services Agreement** and fully achieved within 10 seconds of the time of the start of the **Frequency** increase and it must be sustained at no lesser reduction thereafter. The interpretation of the **High Frequency Response** to a + 0.5 Hz frequency change is shown diagrammatically in Figure CC.A.3.3. If there is an initial inherent delay in the reduction of **Active Power** output following a **Frequency** rise, this must be minimised as far as is reasonably practicable and in any event such a delay should be no longer than two seconds unless in NGET's reasonable opinion a longer delay is unavoidable.

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Primary Response

The automatic increase in **Active Power** output of a **Genset** or, as the case may be, the decrease in **Active Power Demand** in response to a **System Frequency** fall. This increase in **Active Power** output or, as the case may be, the decrease in **Active Power Demand** must be in accordance with the provisions of the relevant **Ancillary Services Agreement** which will provide that it will be released at least linearly with time over the period 0 to 10 seconds from the time of the start of the **Frequency** fall on the basis set out in the **Ancillary Services Agreement** and fully available by the latter, and sustainable for at least a further 20 seconds. The interpretation of the **Primary Response** to a – 0.5 Hz frequency change is shown diagrammatically in Figure CC.A.3.2. If there is an initial inherent delay in the increase of **Active Power** output from a **Genset** following a **Frequency** fall, this must be minimised as far as is reasonably practicable and in any event such a delay should be no longer than two seconds unless in NGET's reasonable opinion a longer delay is unavoidable.

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Figure CC.A.3.2 - Interpretation of Primary and Secondary Response Values

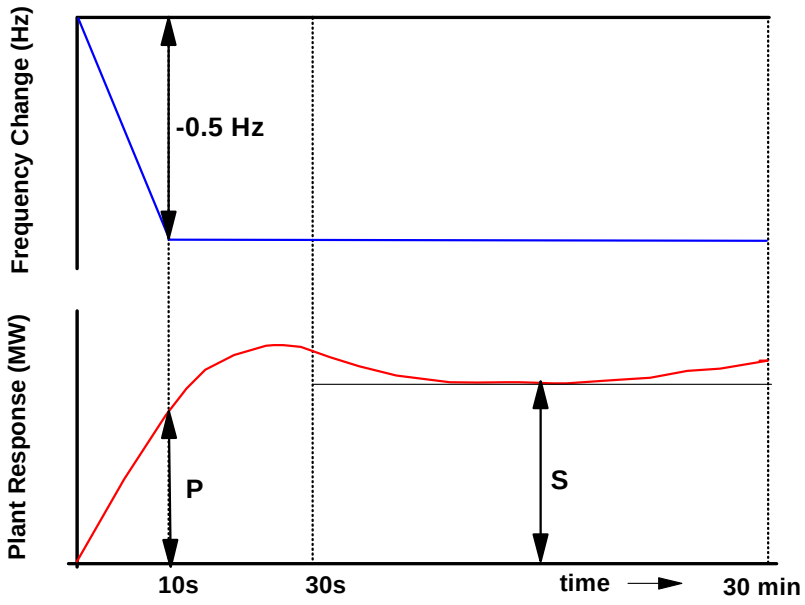

Figure CC.A.3.3 - Interpretation of High Frequency Response Values