Grid Code requirements for Power Park Modules
Voltage Control and Reactive Power capability
A paper by National Grid

Introduction

National Grid has become aware of inconsistencies that have been introduced into the Grid Code connection conditions following the implementation of the changes proposed by the Power Park Modules and Synchronous Generating Units working group. This paper explains the aims of the working group proposals, the inconsistencies that have arisen, and recommends that the Grid Code is modified to reflect the intentions of the proposals.

Background

On April 1st 2008 Issue 3, Revision 26 of the Grid Code came into effect. This revision included the modifications proposed following the work of the Power Park Modules and Synchronous Generating Units working group. These proposals were consulted on in the G/06 consultation (link to consultation paper), modified in response to consultation comments and submitted to OFGEM in December 2007 (link to report), and further modified to retain the reactive capability requirements at the HV side of the connection transformer in Scotland as directed by OFGEM following its decision (link to decision letter) on the proposals.

The Grid Code specifies in clause CC.6.3.4 the voltage range over which the Reactive Power output of a Generator should be fully available. This clause contains relaxations for Power Park Modules and non-synchronous generating units that are embedded at 33kV or below and, until revision 26, for such generation directly connected at 33kV in England and Wales. Figure 4 of the connection conditions shows the effect of the relaxations on the reactive power capability requirement. One of the proposals of the working group was to extend this relaxation to include Power Park Modules and non-synchronous generating units directly connected at 33kV in Scotland.

The text of CC.6.3.4 has been modified appropriately in revision 26. However, the title of Figure 4 and the labels on the reactive power output have not been modified and are inconsistent with the text of C.6.3.4 and the reactive capability requirements of CC.6.3.2(c). The title still refers to England and Wales rather than the whole of the GB transmission system and the axis does not reflect the fact that, in Scotland, the reactive power capability requirement of 33kV connected generation is specified at the HV side of the transformer rather than the Grid Entry Point and may not be 0.95 power factor lead/lag at the Grid Entry Point.

Appendix 7 to the connection conditions was introduced by the proposals of the Power Park Modules and Synchronous Generating Units working group. This appendix specifies the voltage control system performance requirements for Power Park Modules and non-synchronous generating units. Figures CC.A.7.2.2b and CC.A.7.2.2c show the required operating envelopes for the control system and include the GB wide relaxations of CC.6.3.4. The figures are described in CC.A.7.2.2.4. This

clause only applies the relaxations to England and Wales, and not Scotland. This is not consistent with the recommendations of the working group and the Authority decision.

Clause CC.A.7.2.2.7 specifies the reactive capability requirements for Power Park Modules, DC converters and non-synchronous generating units. It aims to ensure that reactive compensation plant is not switched out if the voltage becomes very high or very low. As the reactive power output of compensation equipment often depends on voltage, the requirements of this clause are specified in terms of reactive current rather than reactive power. The last sentence of the clause incorrectly refers to leading Reactive Power rather than leading reactive current.

Proposed Grid Code changes

NGET propose to modify the connection conditions of the Grid Code to ensure they consistently reflect the proposals of the Power Park Modules and Synchronous Generating Units working group and the Authority decision. The Code changes are shown in the appendix and can be summarised as follows:

- The title of Figure 4 refers to the Grid Entry Point rather than the Grid Entry Point in England and Wales

- The reactive power axis labels of Figure 4 acknowledge that the Grid Entry Point requirement in Scotland may not be 0.95 power factor lead/lag

- The text of CC.A.7.2.2.4 applies the relaxations to the whole GB transmission system rather than England and Wales

- The text of clause CC.A.7.2.2.7 requires the generator to maintain maximum leading reactive current output for voltage rises above 105%.

Recommendations

The GCRP is invited to agree that the proposals discussed above and shown in the appendix are consulted on by the industry with a view to modifying the Grid Code.

Appendix – proposed Grid Code modifications

Proposed additions are shown in red, deletions with a line through.

CC.6.3.4 At the **Grid Entry Point** the **Active Power** output under steady state conditions of any **Generating Unit, DC Converter** or **Power Park Module** directly connected to the **GB Transmission System** should not be affected by voltage changes in the normal operating range specified in paragraph CC.6.1.4 by more than the change in **Active Power** losses at reduced or increased voltage. The **Reactive Power** output under steady state conditions should be fully available within the voltage range ±5% at 400kV, 275kV and 132kV and lower voltages, except for a **Power Park Module** or **Non-synchronous Generating Unit** if **Embedded** at 33kV and below (or directly connected to the **GB Transmission System** at 33kV and below) where the requirement shown in Figure 4 applies.

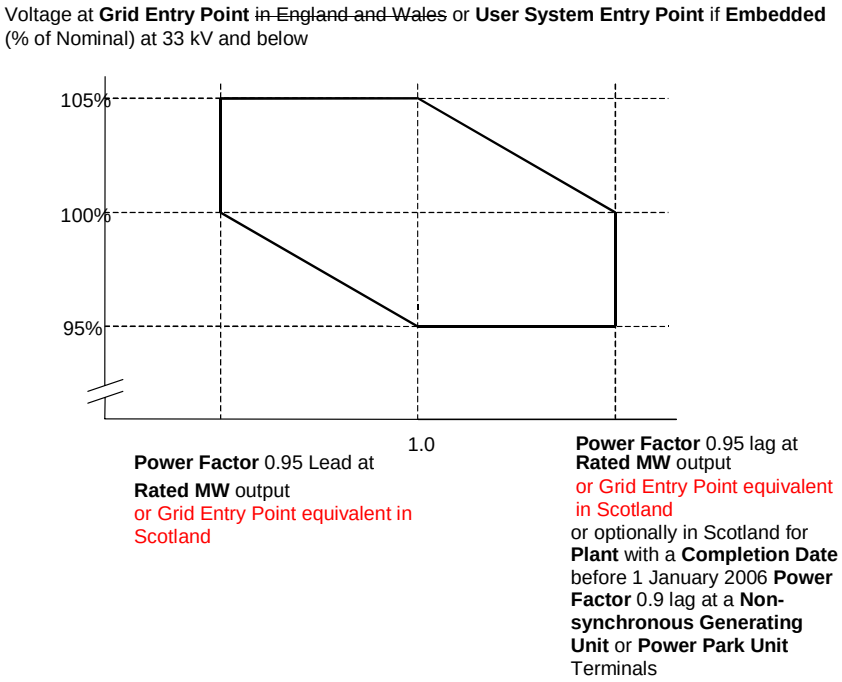

Figure 4

CC.A.7.2.2.4 Figure CC.A.7.2.2b shows the required envelope of operation for **Non-Synchronous Generating Units**, **DC Converters** and **Power Park Modules** except for those **Embedded** at 33kV and below or directly connected to the **GB Transmission System** ~~in England and Wales~~ at 33kV and below. ~~It should be noted that where the **Reactive Power**~~

~~capability requirement of a directly connected **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** in Scotland, as specified in CC.6.3.2 (c), is not at the **Grid Entry Point**, the values of Qmin and Qmax shown in this figure will be as modified by the 33/132kV or 33/275kV or 33/400kV transformer.~~ Figure CC.A.7.2.2c shows the required envelope of operation for **Non-Synchronous Generating Units**, **DC Converters** and **Power Park Modules Embedded** at 33kV and below or directly connected to the **GB Transmission System** ~~in England and Wales~~ at 33kV and below. It should be noted that where the **Reactive Power** capability requirement of a directly connected **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** in Scotland, as specified in CC.6.3.2 (c), is not at the **Grid Entry Point**, the values of Qmin and Qmax shown in this figure will be as modified by the 33/132kV or 33/275kV or 33/400kV transformer. The enclosed area within points ABCDEFGH is the required capability range within which the **Slope** and **Setpoint Voltage** can be changed.

CC.A.7.2.2.7 For **Grid Entry Point** voltages (or **User System Entry Point** voltages if **Embedded**) below 95%, the lagging **Reactive Power** capability of the **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** should be that which results from the supply of maximum lagging reactive current whilst ensuring the current remains within design operating limits. An example of the capability is shown by the line DE in figures CC.A.7.2.2b and CC.A.7.2.2c. For **Grid Entry Point** voltages (or **User System Entry Point** voltages if **Embedded**) above 105%, the leading **Reactive Power** capability of the **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** should be that which results from the supply of maximum leading reactive current whilst ensuring the current remains within design operating limits. An example of the capability is shown by the line AH in figures CC.A.7.2.2b and CC.A.7.2.2c. Should the **Reactive Power** output of the **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** reach its maximum lagging limit at a **Grid Entry Point** voltage (or **User System Entry Point** voltage if **Embedded**) below 95%, the **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** shall maintain maximum lagging reactive current output for further voltage decreases. Should the **Reactive Power** output of the **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** reach its maximum leading limit at a **Grid Entry Point** voltage (or **User System Entry Point** voltage if **Embedded**) above 105%, the **Non-Synchronous Generating Unit**, **DC Converter** or **Power Park Module** shall maintain maximum leading ~~**Reactive Power**~~ reactive current output for further voltage increases.