Making a positive difference for energy consumers

Change proposal:	**Grid Code GC0040: Information Required to Evaluate Sub-synchronous Resonance (A/12)**		
Decision:	The Authority[1] directs that the proposed change to the Grid Code[2] be made		
Target audience:	National Grid Electricity Transmission plc (NGET), Grid Code users and other interested parties		
Date of publication:	30 July 2013	Implementation Date:	19 August 2013

Background to the change proposal

Sub-synchronous resonance is the phenomenon whereby the turbine and shaft system of a synchronous generator can oscillate with the electricity network and/or the equipment connected to it. The oscillations of concern occur at frequencies of less than 50Hz and are independent of the 'grid frequency'. There are certain frequencies where this effect can occur; these are called resonant frequencies. In some circumstances sub-synchronous resonance can adversely affect synchronous generators and the system.

Individual synchronous generators provide positive damping to the system. Positive damping reduces system oscillations, negative damping increases system oscillations. The amount of damping a generator provides depends on the design of its turbine and shaft, and varies with the frequency applied to it. When different synchronous generators are connected to the same area of network, the different damping characteristics of these generators can unfavourably coincide and form resonant frequencies – frequencies at which the damping is low or negative and so oscillations can increase.

The oscillations that result from sub-synchronous resonance are usually initiated by small disturbances on the network, such as routine network switching or sudden changes in demand, which introduce oscillations onto the network. Normally these oscillations are quickly reduced by the damping effect of the electricity network. However, if these oscillations are at a resonant frequency and are not sufficiently damped, then the oscillations can increase and sub-synchronous resonance occurs. This can damage synchronous generators.

Two broad changes to the GB electricity system will affect the likelihood of sub-synchronous resonance occurring:

1. The increasing use of inverter technologies, such as in High Voltage Direct Current (HVDC) connections. The high speed controls used in these technologies can introduce negative damping to the system, thus increasing the likelihood of sub-synchronous resonance occurring. However, if designed to do so, they can provide positive damping and so reduce the likelihood of sub-synchronous resonance occurring. In order to do this effectively, it is usually necessary to evaluate the resonant frequency characteristics of all local power system components, including synchronous generators.

2. The introduction of Series Capacitive Compensation (SCC) to maximise the transfer capability of network circuits. SCC can create the conditions necessary for sub-synchronous resonance.

[1] The terms 'the Authority', 'Ofgem' and 'we' are used interchangeably in this document. Ofgem is the Office of the Gas and Electricity Markets Authority.
[2] This document is notice of the reasons for this decision as required by section 49A of the Electricity Act 1989.

As the use of HVDC technology and SCC in the National Electricity Transmission System increases, National Grid Electricity Transmission plc (NGET) will need to ensure sub-synchronous resonance can be considered on a regular and ongoing basis. This will require synchronous generators to provide technical information about their plant to NGET, so that NGET and other affected parties can calculate resonant frequencies. The Grid Code does not currently specifically provide for the information exchange required to fully assess sub-synchronous resonance.[3] Therefore, NGET considers that the Grid Code should be modified to require synchronous generators to provide this information. NGET considers that an additional benefit of specifying the information required is that existing generators can see what information may be requested from them (see footnote 3).

The change proposal

Grid Code Modification proposal GC0040 ('GC0040')[4] was raised by NGET. It proposes to require synchronous generators to submit to NGET information additional to that which is already required under the Grid Code. The additional information would be submitted as part of the Detailed Planning Data II (DPD II) submissions, and would be required from all eligible generators[5]. GC0040 proposes that the provision of this additional information would only apply to synchronous generators with a completion date on or after 1 April 2015. The additional information relates to the mechanical properties of the generator/shaft/turbine system.

GC0040 does not propose to impose this information provision requirement on synchronous generators with a completion date before 1 April 2015 as:

- most existing generators do not have ready access to the required information and would incur costs in obtaining it;
- the costs of obtaining the information are likely to be high compared to those incurred by a generation developer who has been able to factor this information requirement into their development and has good access to manufacturer expertise; and
- the information won't be required in all cases.

GC0040 would require additional text to be inserted in paragraph PC.A.5.3.2 and in Schedule 1 of the Data Registration Code (DRC) of the Grid Code.[6]

GC0040 (previously called A/12) was submitted to the Grid Code Review Panel (GCRP) for their views in January 2012. The GCRP determined that the proposal should progress to an industry consultation, which was completed in February 2012. Five responses were received, all of which were broadly supportive of the proposal. In July 2012, the GCRP recommended that a wider range of views on how sub-synchronous resonance should be managed should be sought. Further work was undertaken and an industry workshop was held in May 2013. Attendees at the workshop were satisfied that GC0040 remained a valid

[3] Generators currently provide information to NGET in Standard Planning Data and Detailed Planning Data submissions. Under Grid Code Planning Code A.7 (PC.A.7), NGET "may reasonably require additional data to represent correctly the performance of such **Plant** and **Apparatus** on the **System**, where the present data submissions would prove insufficient for the purpose of producing meaningful **System** studies for the relevant parties." NGET has used this process to gather data from existing synchronous generators for the purpose of evaluating sub-synchronous resonance.

[4] Grid Code proposals, final reports and representations can be viewed on NGET's website at: http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/consultationpapers/

[5] NGET email to Ofgem: "The data submission will be required from Synchronous Generators connected directly to the National Electricity Transmission System (PC.A.5.1.1) and Embedded Large Power Stations, Embedded Medium Power Stations subject to a Bilateral Agreement and Network Operators in respect of Embedded Medium Power Stations not subject to a Bilateral Agreement (ie Licence Exempt Embedded Medium Power Stations - LEEMPS). The only exception to this is in respect of Embedded Medium Power Stations (either Licensed or License Exempt) where the Power Station is connected at a Voltage level below the voltage level of the Sub-Transmission System (i.e. two transformer levels from the National Electricity Transmission System) as defined in PC.A.5.1.2".

[6] Numbering based on Grid Code Issue 5 Revision 2.

proposal, but suggested a follow up workshop should be held in autumn 2013 following implementation of GC0040, if approved.

NGET submitted the final report for GC0040 to the Authority on 27 June 2013. After we identified an error with the proposed legal text, NGET resubmitted the final report on 15 July 2013 with corrected proposed legal text. NGET also used the resubmission to make three other changes to the proposed legal text to provide greater clarity.

NGET's recommendation

NGET recommends to the Authority that GC0040 is accepted and recommends implementation on 19 August 2013, subject to an Authority decision to approve GC0040.

NGET considers that GC0040 would better facilitate Grid Code objectives (i), (ii) and (iii)[7]. In NGET's view the additional information provision that GC0040 proposes will:

- provide clarity with respect to the information required to assess sub-synchronous resonance issues and ensure the provision of information is considered at an appropriate stage by synchronous generators;
- enable NGET to better assess and understand the implications of sub-synchronous resonance on the transmission system, facilitating the connection of new generation and transmission technologies; and
- facilitate the timely implementation of appropriate mitigation measures, resulting in a greater connection of generation and ensuring security of supply.

NGET considers that, in the absence of the information provision proposed by GC0040, it is possible that some Users[8] could be denied access to the transmission system due to insufficient data being available to assess their impact.

Our decision

We have considered the issues raised by the change proposal and in the final Report on GC0040 dated 15 July 2013. We have considered and taken into account the responses to NGET's consultation on the change proposal which are included in the final Report. We have concluded that:

1. implementation of the change proposal will better facilitate the achievement of the objectives of the Grid Code[9]
2. approving the change is consistent with the Authority's principal objective and statutory duties[10].

Reasons for our decision

This section sets out our assessment against the Applicable Grid Code Objectives[11] which we consider are impacted by this proposal. We consider that the proposal has no impact on Applicable Grid Code Objective (iv).

Applicable Objective (i) 'to permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity'.

[7] As set out in Standard Condition C14 (1)(b)(i)–(iii) of NGET's Transmission Licence, see http://epr.ofgem.gov.uk/document_fetch.php?documentid=14343.
[8] As defined in the Grid Code.
[9] As set out in Standard Condition C14(1)(b) of NGET's Transmission Licence.
[10] The Authority's statutory duties are wider than matters which NGET must take into consideration and are detailed mainly in the Electricity Act 1989 as amended.
[11] As set out in Standard Condition C14(1)(b) of NGET's Transmission Licence.

NGET considers that the proposed changes will better facilitate Applicable Objective (i). In its view, GC0040 provides clarity regarding the information it requires to efficiently tackle the problem of sub-synchronous resonance on the transmission system and ensure that this information provision can be considered during project development. NGET also considers that GC0040 better facilitates the information exchange required for the efficient development of a secure transmission system and facilitates the use of new generation and transmission technologies.

During the industry consultation, none of the respondents commented on whether GC0040 facilitates Applicable Objective (i).

We consider that GC0040 will better facilitate Applicable Objective (i). We consider that the issue of sub-synchronous resonance will become increasingly prevalent, and that a comprehensive data set will help NGET to more efficiently and economically assess possible sub-synchronous resonance issues, and so promote the development, maintenance and operation of an efficient, coordinated and economical system.

We recognise that NGET can already request additional data through the PC.A.7 process. However, given the likely increasing requirement for this data, we consider that GC0040 presents a more economical and efficient method of collecting this data. We consider that it is better for generators to be aware what information will be required at the beginning of the project development process rather than to be asked for it on an ad hoc basis, post commissioning.

For the reasons above, we consider that GC0040 better facilitates this objective.

Applicable Objective (ii) 'to facilitate competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms with neither prevent nor restrict competition in the supply or generation of electricity)'.

NGET considers that the proposed changes will better facilitate Applicable Objective (ii). In its view, the proposal facilitates the information exchange required to assess sub-synchronous resonance issues. In the absence of this information and assessment, access to the transmission system could be denied in some cases.

The respondents to the industry consultation did not comment specifically about whether GC0040 facilitated Applicable Objective (ii). Two respondents observed that imposing the information requirement on existing synchronous generators would expose them to additional costs and the information would be difficult to obtain.

We agree with NGET and the two consultation respondents that the GC0040 additional information requirements should not be applied to synchronous generators with a completion date before 1 April 2015. We consider that, as the information will not be required in all cases from this group and there is already a mechanism to request the information on a case by case basis as required, this may impose unnecessary costs and not be efficient.

We understand that there will be a cost for synchronous generators to meet the additional information provision imposed by GC0040. However we consider that, as GC0040 will clearly state these information requirements up front, any additional costs resulting from GC0040 will be negligible compared to the overall cost of developing a synchronous generating site and so should not prevent competition in the generation of electricity. We also consider that providing the information during the project development process will be cheaper and easier than trying to find the information once the site is operational.

We consider that if NGET does not have ready access to the technical data required to assess sub-synchronous resonance, then access to the network, and so the electricity market, could be delayed for some new connections. In extreme cases, if information is not available and has to be approximated, the resulting margin of error required for preventative measures may make it uneconomical to develop a synchronous generation site. Installation of SCC, to increase the transfer capability of existing circuits, and HVDC, to bring generation from outside GB to the GB market, could similarly be affected.

For the reasons above, we consider that GC0040 better facilitates this objective.

Applicable Objective (iii) 'subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole'.

NGET considers that the proposed changes will better facilitate Applicable Objective (iii). In its view, the proposal facilitates the information exchanges required to assess sub-synchronous issues and to develop mitigation measures or modify designs as required.

The respondents to the industry consultation did not comment specifically about whether GC0040 facilitated Applicable Objective (iii). However, two respondents stated that broader industry discussion about the use of SCC and HVDC technologies and their impact is required to agree how the interactions between these technologies and synchronous generators should be managed. One other respondent considered it appropriate to start development of Grid Code conditions for generator based sub-synchronous resonance.

We consider that GC0040 will better facilitate this Applicable Objective. Ready access to the technical data required to assess sub-synchronous resonance will facilitate the understanding of sub-synchronous resonance and the development of mitigation measures, and so contribute towards system stability and a lower risk of potentially harmful sub-synchronous resonance effects.

We note the three respondents' views that further work and discussion is required on sub-synchronous resonance and SCC, HVDC technology and synchronous generators. We agree that this discussion needs to take place within the industry, but do not consider that this should delay or affect, or is mutually exclusive to, the approval of GC0040.

Decision notice

In accordance with Standard Condition C14 of NGET's Transmission Licence, the Authority hereby directs that Grid Code change proposal GC0040 *'Information Required to Evaluate Sub-synchronous Resonance'* be made. We agree that the implementation date should be 19 August 2013.

Gareth Evans
Head of Profession Engineering
Signed on behalf of the Authority and authorised for that purpose